THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 61 Thursday, November 2, 1939 No 1211

PUBLISHED WEEKLY

Subscription Terms : 17s. 6d. per annum.
Foreign and Colonial : 20s. per annum.
All Subscriptions are payable in advance.

THE FOUNDRY TRADE JOURNAL
49, Wellington Street, London, W.C.2.

EMERGENCY ADDRESS
to which all communications should be sent until further notice :—
3, Amersham Road, HIGH WYCOMBE, Bucks
Telegraphic Address : "Zacatecas, High Wycombe."
Telephone : HIGH WYCOMBE 1792 (3 lines).

OFFICIAL ORGAN OF

The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT : 1938-39

W. B. Lake, J.P., Lake & Elliot, Limited, Braintree, Essex.

LIST OF SECRETARIES—

General Secretary : T. Makemson, Saint John Street Chambers, Deansgate, Manchester, 3. London Office : 49, Wellington Street, London, W.C.2.

Birmingham, Coventry and West Midlands : A. A. Timmins, A.I.C., 21-23, St. Paul's Square, Birmingham, 3.

East Midlands : B. Gale, "Parkdale," Boulton Lane, Alvaston, Derby.

Lancashire (*pro tem*) : A. Boyes, 377, Liverpool Road, Patricroft, Manchester.

London (*pro tem*) : H. W. Lockwood, Stewarts and Lloyds, Limited, Winchester House, Old Broad Street, E.C.2

Middlesbrough : G. P. Kirk, North-Eastern Iron Refining Company, Limited, Stillington, Stockton-on-Tees.

Newcastle-upon-Tyne : C. Lashly, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead.

Scottish : J. Bell, 60, St. Enoch Square, Glasgow.

Sheffield : T. R. Walker, M.A., F.I.C., 11, Broomgrove Crescent, Sheffield, 10.

Wales and Monmouth : J. J. McClelland, 12, Clifton Place, Newport.

West Riding of Yorkshire : S. W. Wise, 110, Pullan Avenue, Ecclesshill, Bradford.

South Africa : F. C. Williams, Mutual Building, Corner of Harrison and Commissioner Streets, Johannesburg:

Bristol : A. Hares, Park Crescent, 648, Stapleton Road, Bristol, 5.

Burnley : H. Buckley, Ellsmere, Norfolk Avenue, Burnley, Lancs.

East Anglian : J. L. Francis, 12, Glenhurst Avenue, Colchester Road, Ipswich.

Falkirk : T. R. Goodwin, "Viewfield," Falkirk Road, Bonnybridge, Scotland.

Lincoln : E. R. Walter, M.Sc., The Technical College, Lincoln.

The Institute of Vitreous Enamellers

President : Sir Harold Hartley, F.R.S., Euston Station, London, W.C.1.

Chairman : W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.

Hon. Secretary : Mrs. Kenneth Hill, 132, St. Stephen's House, Victoria Embankment, London, S.W.1.

Foundry Trades' Equipment and Supplies Association

President : G. E. France, August's, Limited, Thorn Tree Works, Halifax.

Secretary : K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President : W. E. Clement, Moris Foundry, New Dock, Llanelly.

Secretary : J. D. D. Davis, 9, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. are :—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone : Colmore 4274-4275 Telegrams : CIRA

The B.C.I.R.A. Scottish Laboratories are :—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone : 332

Contents

	PAGE
Cupola Practice	297
Foundry Research	297
Collection of Scrap	298
I.B.F.—Election of New Members	298
Random Shots	298
The Cupola and the Melting of Iron	299
I.B.F.—West Yorkshire Branch opens New Session	301
Bellfounders turn Gunfounders	302
Welding Aluminium Castings	302
Phosphor-Bronze Castings of Heavy Sections	303
Metal to Rubber Joints	304
British Cast Iron Research Association	306
Supplies for National Purposes	306
Vitreous Enamelling Section — Workable Control System and Benefits to the Enamel Plant	307
Book Review	310
Enamelling Defects Due to the Foundry	312
The Week's News in Brief	314
Trade Talk	314
Personal	314
Reports and Dividends	314
Obituary	314
Forthcoming Events	314
Raw Material Markets	316

Cupola Practice

There has, in recent times, been a plethora of quasi-mathematical treatments of some phases of cupola practice, and these have contributed but little, in our opinion, to a better understanding of fundamentals. The Papers which we have in mind are mostly of Continental origin, and thus it was with a considerable amount of pleasure that we read Prof. Girardet's contribution to the last congress of the French Foundry Technical Association. This was due to the fact that he dealt with the whole of the subject and did this in such a way as to give a connected story of each phase with due regard to its relative importance. His detailing of the four fundamentals does help to institute a rational control. His first postulation that the depth of the zone of maximum temperature is a function of the average cross-section of the pieces of coke used, though eighty-odd years old, will come as a new thought to most foundrymen.

The only part of Prof. Girardet's conclusions which will not meet with general acceptance is his complete destruction of the solid cementation theory. This theory is still widely held by many prominent British technicians, and Mr. E. Longden has decided to carry out experiments designed either to confirm or refute the conclusions put forward. Another statement which caused us no little surprise is that radiation losses are less where a receiver is used than when the metal is retained in the well of the furnace. This is ascribed as being due to the presence of coke. It would be helpful if someone could amplify this reasoning. We think most of our readers will agree with the notion that, during the operation of an ordinary cupola involving periodic tapping, the bed coke forms a sort of raft floating on the liquid iron and supporting the column of stock above it. The development of maximum combustion at the periphery of the crucible forms the basis of a good deal of sound reasoning by the Professor, and difficulties of separating the various charges are shown to be a consequence of this irregularity of combustion. As a practical contribution to a proper understanding of existing cupola practice and its future potentialities, we deem Prof. Girardet's Paper to be of outstanding importance.

Foundry Research

It is not possible to assess the work of a research association by its publications, but they do serve as a guide to the lines upon which it is working. A list of reports published during the last two years by the British Cast Iron Research Association shows a total of forty-three. Moulding sands are covered by three reports, including one outlining methods of testing and control. The influence of various factors on cast iron is dealt with in three reports—one being a further study on the effect of copper, the second phosphorus and silicon as related to soundness, and the third on aluminium in cast iron. Other phases of cast iron are dealt with in three further reports concerned with shrinkage, the high-duty types, and the iron-carbon diagram. Various aspects of cupola practice are the subjects of five Papers, and include the melting of borings; coke; receivers and continuous melting practice; refractory linings; and the blast and an instrument for its measurement. Reports of general character number about fifteen. Entering into this field are two dealing with American foundry practice, whilst others cover such diverse subjects as foundry layout, the use of denseners, an impact testing machine, pig-iron grading, polishing microspecimens and a new type of optical pyrometer. A couple of reports are devoted to vitreous enamelling, whilst the present conditions are responsible for some work on A.R.P. for cupolas. The Association naturally avails itself of the technical institutes as a method of publication, and the list of Reports is materially augmented thereby. Thus, in a list of Bureau Reports there is a mixture of Papers written by the members of the staff and contributions to the study of cast iron from external sources.

During the last two years, the Association has made available about forty translations, and with one solitary exception (Swedish) all these are from German sources. Surely, during this period there has been something worth while emanating from the French technical Press! To our mind, it is now on a higher plane than the German, especially in interpretation. Regarding the Reports as a whole, it can be said that a good service is being given to the industry, but we should like to see more imagination displayed. Additionally, more fundamental work ought to be undertaken. Obviously, we are not referring to the present conditions, which demand the carrying out of urgent work for the Government departments.

Collection of Scrap

A NATIONAL CAMPAIGN

A scrap collection campaign is being embarked upon by the British steel industry. It is emphasised that there is no scarcity of raw material for the steel furnaces, but it is necessary to look ahead. An acceleration of scrap supplies from the regular sources, and a thorough clearing out of otherwise neglected dumps, will reduce the proportion of scrap that must be imported, thereby easing demands on ocean transport and saving foreign exchange. Some 180,000 letters are being sent out to manufacturers and industrial undertakings, including firms which do not produce scrap in the ordinary course of their work, but may well be able to contribute discarded machine parts or obsolete plant. The letter says:—

"No doubt you will appreciate the special importance at the present time of augmenting the national supplies of scrap iron and steel, and ensuring that these become available to the steelworks at the earliest possible moment. Many factories and commercial premises contain such items as discarded machines, machine parts, old steel pulleys, shafts, broken tools, disused piping, metal sheeting, unwanted dies, jigs, old metal containers. These and any articles containing iron or steel can now be put to national use. You would be rendering a very useful service if you would have a special search made, and any such material collected together and disposed of forthwith. The scrap-iron merchants and dealers in your district, some of whom advertise in the Press, would be pleased to quote for this material and arrange prompt collection. You will appreciate that, although, in the national interest, prices to the final consumer are controlled, these prices bear no relation to the price of scrap at its source, as transport and preparatory operations are necessary before the metal is delivered in suitable form to the steelworks."

Collecting the Material

With each letter will be enclosed a business reply postcard. The returns made on the cards will be classified by towns or districts. Where there are difficulties in getting the scrap collected the Iron and Steel Control will endeavour to put the firm in touch with a local scrap merchant. If for any reason that cannot be done, it may be possible to arrange for lorries to make collecting rounds, at no expense to firms with scrap for disposal.

Scrap-collecting campaigns have broken down in the past over the difficulty of locating and collecting relatively small tonnages, which, nevertheless, mount up to formidable quantities. This time it is hoped to overcome that obstacle and to extend the campaign into the remote countryside.

Firms in the London postal area were circularised last week. This week it has been the turn of the Midlands, one of the most important scrap-producing areas of Britain. In succeeding weeks the campaign will be extended to Yorkshire, Scotland, the South of England, the Eastern Counties, Wales and the South-West, and, finally, the Home Counties. This postal appeal is to be regarded as only the beginning of an effort that will be continued till a much accelerated supply of scrap is assured from home sources. At a later stage the campaign will reach the householder.

Origin of Scrap

Large tonnages of scrap are used by the British steel industry each year, apart altogether from the more specialised material consumed by steel and iron founders and by wrought-iron makers. In 1937, a representative year, about 7½ million tons of scrap were melted in turning out the 13 million tons of steel ingots produced in this country. Of the tonnage melted, some 2,850,000 tons of scrap steel and 226,000 tons of scrap cast iron were supplied by the steelworks themselves. The cast iron for the most part came from broken-up moulds. About 4,034,000 tons of scrap steel and 367,000 tons of scrap cast iron were bought from outside sources. Taking an average value of £3 per ton, in round figures, a turn-over of purchased scrap would thus be near £13 million a year.

The proportion of scrap used in furnace charges varies greatly from time to time, and from district to district. Normal present-day practice varies from about 75 per cent. in Sheffield to around 25 per cent. in Lincolnshire.

Institute of British Foundrymen

ELECTION OF NEW MEMBERS

At a Council meeting of the Institute of British Foundrymen, held in Birmingham on October 21, the following were elected to the various grades of membership:—

As Members.

W. J. Armstrong, chemist, Wolsingham Steel Company, Limited, County Durham; L. A. Bailey, manager, J. Redgate, Limited, Nottingham; M. Barker, managing director, Durban Falkirk Iron Company, Limited, Durban, S.A.; W. Brindley, foundry manager, Marshall & Sons (Successors), Limited, Gainsborough; J. R. Clayton, proprietor and foundry manager, P. B. Wolfe, Stockport; J. E. Cooke, foundry manager, W. & J. F. Jones, Limited, Pendlebury; E. M. Currie, manager, International Meehanite Metal Company, Limited, London; H. B. Fisher, foundry manager, Glyn Engineering Works, Limited, Pontypool; C. S. Gill, director, Davy & United Roll Foundry, Limited; R. G. Harrington, sales manager, Bradley & Foster, Limited, Darlaston; F. Horn, intelligence officer, British Aluminium Company, Limited, London; G. Khandelwal, B.Sc., manager, Bhanamal Gulzarimal, Delhi; A. H. Mackay, foreman patternmaker, Central Engineering Works, Limited, Johannesburg, S.A.; J. A. MacKinlay, metal merchant, Walbrook, London; W. Mosley, traveller, New Conveyor Company, Limited, Smethwick; H. Piper, technical manager, Ridsdale & Company, Limited, Middlesbrough; J. Sissener, metallurgist and foundry manager, Myrens Verksted, Oslo; S. Webster, metallurgist, Wright, Boag & Company, Benoni, S.A.

As Associate Members.

H. O. Allman, foundry estimating engineer, Dunswart Iron & Steel Company, S.A.; W. J. Barnett, assistant foundry foreman, Mechanical Department, G.I.P. Railway, Parel, India; O. Bateson, patternmaker, De Havilland Aircraft Company, Bolton; J. H. Boughey, foreman moulder, C. P. Kinnell & Company, Limited, Thornaby-on-Tees; A. Buckley, patternmaking instructor, L.C.C. Wandsworth Technical College; L. Clarke, ratefixer, J. Harper & Company, Limited, Willenhall; J. C. W. Davies, metallurgical chemist, English Electric Company, Limited; J. Hill, moulder, Heywood Foundry, Limited, Heywood; E. Jones, metallurgical chemist, Hopkinsons, Limited, Huddersfield; W. D. McCrone, instructor, Technical College, Johannesburg, S.A.; F. J. Manion, foundry superintendent, S. Russell & Company, Limited, Walsall; J. Nicholson, moulder, D. Owen & Sons; E. H. Slaney, assistant metallurgist, Davis Gas Stove Company, Limited, Luton; H. Stone, foundry foreman, J. Hall & Son; A. P. Wallace, moulder, G. & J. Weir, Limited, Cathcart; E. J. Ward, patternmaker, Bank Hardware Manufacturing Company, Limited, Quarry Bank; E. White, patternmaker, Metropolitan-Vickers Electrical Company, Limited, Manchester; K. J. Zwanziger, patternmaker, Eagle Brass Foundry, Johannesburg, S.A.

As Associates.

J. H. Jenkins, representative, Bellamy & Lambie, Johannesburg, S.A.; G. N. Johnston, patternmaker, Wright, Boag & Company, Johannesburg, S.A.; B. Malone, moulder, Howard & Bullough, Limited, Accrington.

As Associate (Student).

H. C. G. Wilson, assistant metallurgist, Northern Aluminium Company, Limited, Birmingham.

Random Shots

Fearing that control might possibly affect his interests, an apprehensive reader has contributed the following story:—

ALICE IN FOUNDRYLAND.

CHAPTER I.

SQUEAL HOUSE.

Alice was awakened by a heavy snore from the Dormouse, who was propped up on a huge pile of papers at the desk opposite.

"Gracious me!" exclaimed Alice, "I must have been asleep!"

"Of course you were asleep," murmured the Dormouse, without opening his eyes, "we're all asleep here."

"Come now, this won't do!" said Alice, speaking sharply to herself. "You really must make an effort to understand this Explanatory Leaflet or we shall never get anywhere. Where were we, anyway? Oh, yes, I remember, it began like this . . . Classes One to Seven . . . No, no, that's all wrong; begin again right at the beginning. Let me see . . . 2(*a*) by 2(*b*) equals . . . Oh, dear, I never could do algebra. Perhaps it would all be clearer if only I could see one of the licences."

"No hope of that," said the March Hare, "the Dormouse is sitting on them. He has been sitting on them for weeks."

"Months," corrected the Dormouse, with a heavier snore than usual.

"Still, it doesn't matter," continued the March Hare, "there is always the Duration."

"What Duration?" asked Alice. "The one they say we're here for," replied the March Hare. Just then the White Rabbit rushed in, exclaiming in great excitement:

"Bless my ears and whiskers—there's a Foundryman down on the tenth floor who actually wants some Pigs."

"Vulgar fellow," drawled the March Hare, "doesn't he know they're all controlled?"

"Off with his head!" screamed the Dormouse, really awake at last.

"Nonsense," said Alice. "Why shouldn't he have Pigs if he wants them?"

"Because," replied the March Hare, "the Mad Hatter said . . ."

"Hush!" cried the White Rabbit, glancing fearfully over his shoulder. "You mustn't mention *him*! Haven't you heard? He's got a Very Important Job . . . a Very Important Job Indeed."

"I don't care," said Alice, "if the Foundryman wants some Pigs I think he ought to have them."

"That only goes to show how ignorant you are," said the March Hare. "As if it wasn't hard enough to count these wretched pigs while they keep on going round and round . . ."

"Well," snapped Alice, "if there are enough to go round and round, I don't know what you want to control them for."

"That's just it. If we can only control them hard enough they will stop going round, and then this will really be Squeal House."

"Oh, I see," said Alice, "the pigs and sows, of course."

"No," said the March Hare, "the Foundrymen will do all the squealing."

"Tea-time! Tea-time!" shouted the White Rabbit and the Dormouse both together, and immediately the tap of the typewriters and the buzz of conversation were drowned in the clatter of thousands of cups and saucers.

* * *

For a week's respite, many thanks.

"MARKSMAN."

The Cupola and the Melting of Iron

PROFESSOR GIRARDET'S INTERESTING STUDY

Due probably to the fact that Prof. L. F. Girardet is a foundry owner, his technical Papers command wider attention than those written by the purely academical or practical author. Moreover, he usually manages to strike a note of a novel character. The Paper which he read at the Annual Meeting of the Association Technique de Fonderie was no exception, and although we have published dozens of articles dealing with cupola practice, none has appealed to us so much as this particular contribution, because of its unique angle of approach. Below we have translated its more interesting features.

Four Principles Govern Cupola Operation

(1) The zone carrying the maximum temperature is that situated above the tuyeres, extending vertically ten times the average diameter of the pieces of fuel. This rule results from tests carried out by Sainte-Claire Deville published in 1857 in the Annales de Chemie et de Physique. Practical conclusions of an important character appear later in this Paper.

(2) In the gas which escapes from this region of maximum temperature there is no longer any oxygen. It is replaced volume for volume by CO_2. The total volume of the gaseous products of combustion converted to the temperature and pressure of the air blown in is therefore precisely equal to this volume. Instead of containing 79 volumes of nitrogen and 21 volumes of oxygen, it is now made up of 79 volumes of nitrogen and 21 volumes of carbonic acid gas.

(3) The carbon dioxide which leaves the region of maximum temperature reacts with the hot carbon, through the interstices of which it passes on its way to the throat and produces carbon monoxide, CO. The intensity of this action is governed by the time of the contact of the CO_2 with the C, the temperature, and the reactivity of the surface of the coke. This reaction absorbs heat by consuming coke. It is therefore doubly noxious, and the foundryman should make every effort to limit the reaction as much as possible.

(4) The fourth principle was enunciated by Seigle in 1918. Applied to cupola practice it can be given the following form. In the throat gases there is a definite and fixed relationship between the contents of all the gases present. If the mixture only contains nitrogen, carbon dioxide and carbon monoxide, there should be:—

$$4.76\ (CO_2) + 2.88\ (CO) = 100 \text{ vols.}$$

(CO_2) and (CO) represent the respective percentages in the throat gases. If the sampling has been badly done, or if the cupola is being run abnormally badly, it may be that oxygen will be found in the gas; then it is necessary to add it to the (CO_2) in order to satisfy the relation, which now becomes—

$$4.76\ (CO_2 + O_2) + 2.88\ (CO) = 100.$$

APPLICATION OF PRINCIPLES TO THE RUNNING OF THE CUPOLA

Division into Zones

Following the usual custom it is proposed to divide the cupola into zones, but in this case they are to be slightly different.

Bottom Zone or Crucible

This zone is limited at its base by the hearth and at its summit by the tuyere level. Its primary object is that of a collector of liquid metal, which accumulates on the hearth, the balance of the free space being filled by coke. The atmosphere is oxidising at the top in the immediate neighbourhood of the tuyeres and reducing lower down, where the air cannot rapidly renew itself, being constantly in contact with an excess of coke.

The Story of the Coke Bed.—It is generally agreed that the crucible is full of coke on which rests the weight of the column of coke and metal, reaching right up to the throat. It is also said that the coke does not burn, or at least but little, because of the very limited air circulation in this "dead" region and that the molten iron lies in the spaces existing between the pieces of coke. This conception, however, finds no confirmation by observation. By standing at the charging door during a tapping, it is easy to observe the rapid lowering of the level of the charges, by slow successive steps. The movement only stops when the tapping is suspended or the crucible is empty. In a word, changes are taking place as if the column of materials rested on a raft set upon the liquid iron. It thus seems that the following explanation would be nearer to the truth: jets of air from the tuyeres attack and consume the column of coke in the *region* situated against them, more actively higher than lower. However, the ferrostatic pressure tends to lift the coke immersed in the bath of liquid iron, and this pressure buoys up the weight of the column. To this buoyancy there is to be added the sticking to the periphery of the furnace and the central core of the coke, to which reference will be made later. The mass is therefore in unstable equilibrium; when the buoyancy pressure disappears on account of tapping, the materials slip down and settle themselves towards the bottom. These sudden movements occasionally introduce troubles in the running of the plant, as will be shown later.

Phenomena Taking Place in the Crucible

The liquid iron rests for indeterminate periods in the crucible, depending on the amplitude of the tappings. During this time, it follows a course of autopurification through internal reactions, of which it is the centre, until their completion. At the same time, it reacts upon the coke which it washes; the slag which covers it, and the walls of the crucible which contain it. The overall result, which the author has dealt with elsewhere in detail, is a deoxidation, desulphurisation, carburisation and a segregation which brings it to a transitory condition, more or less bordering upon its definite physico-chemical state of equilibrium. The crucible cannot be condemned without reserves, nor can its suppression be advocated. Utilising a receiver or a large distributing ladle, the deoxidising and carburising reactions are eliminated. It then becomes necessary to run the cupola accordingly and to adopt appropriate compositions for the charges. It will be shown later how the zones have to be modified.

Generally speaking, carburisation in the crucible becomes the principal complaint. This factor depends on the reactivity of the coke, and decreases when the quantity of ash increases.* It also depends upon the composition of the iron. Carbon and silicon act against it by slowing up and limiting the penetration of the carbon.[1] On the other hand, manganese favours carburisation. It is not therefore possible, *à priori*, to assess the importance it will have if the properties of the coke and the composition of the iron be ignored. Especially should the state of oxidation in which the running of the cupola has placed the iron before its arrival at the crucible be taken into consideration.

From a purely physical point of view, there is a chilling of the iron by radiation (not compensatable) in the crucible. This loss is greater than where a receiver is used, the iron in these conditions offering a less widespread surface, due to the absence of coke.

* See section on "Zone of Oxidation."

Second or Oxidation Zone

This is the most important one because it is here where the heat is generated which operates the cupola. At its base it is limited by the tuyere level where it makes a common frontier with the crucible. Its upper limit will be defined by *the region of maximum temperature*—a region more or less corresponding to the melting zone, according to the nature of the charge. The depth of the zone is given by the first principle (Sainte-Claire Deville, 1857)—it is *ten times the average diameter of the pieces of coke.*

The surface of separation from the third zone is not a level, as might be expected, allowing for irregularities set up from the slipping of the charge during tapping. It is strongly concave, the concavity being in the direction of the throat. This feature, which has been noted by all students of the distribution of the temperature in the cupola, is due to the easier passage for the gases along the wall. This results in increased combustion at the periphery which introduces important repercussions in the descent of the charge as will be shown later.

The Tuyeres.—These provide the means for the penetration of the air consisting of 79 volumes of nitrogen and 21 of oxygen. It is the latter which reacts on the carbon of the coke according to the following reaction:—$O_2 + C = CO_2 +$ 8,080 calories per kg. of pure carbon. There being no change in volume 100 vols. of air give 100 vols. of gas consisting of 79 vols. of nitrogen and 21 vols. of CO_2. But the 8,080 calories have endowed this gas with a theoretical temperature of 2,020 deg. C. This temperature is lower in practice, because it is coke which is being burnt and not pure carbon. Direct measurements have given figures of the order 1,900 deg. C., a temperature which is distinctly higher than that necessary to melt the most refractory material—usually mild steel scrap—entering into the charge.

Temperature distribution in the second zone.—At tuyere level, the continuous entry of the cold blast opposes the creation of a region of instantaneous combustion, which starts about 1,000 deg. C. The blast takes away from the coke greater quantities of heat than the reduced activity of the combustion can develop. In the upper region, however, where conditions of instantaneous combustion exist, the blast gradually transmits the heat by radiation and conduction towards the lower regions. There is thus created an increasing thickness of the layer whose temperature and oxidation of the carbon are at a maximum, which is automatically limited by the equilibrium between the heat brought in by the blast and that arising from the top of the zone. The influence of the quantity of the blast can therefrom be deduced. Too little blast is associated with insufficiently active combustion, preventing the attainment of maximum temperature, consequent upon a dispersal of the calories produced without their having time to heat the coke, which the calories traverse too quickly.

Case of Hot Blast.—Hot blast has been condemned by many experts of earlier days; to-day they postulate, with good reason, that experimental proof is showing up its advantages. By preheating the blast, the cooling effect at the nose of tuyeres is lessened, because of the inherent heat carried in. If this be sufficient to raise the temperature to that of the instantaneous combustion of the coke, the maximum temperature would be developed in this region and there would no longer be the nearby zone, which yields the maximum temperature for a distance of about 10 diameters of the fuel (Ste. Claire Deville). This therefore would start at the tuyeres, which implies that the depth of the zone would be reduced and only be equal to that of the region of maximum temperature.

In actual practice the blast is not heated to such a high temperature, at least up to now.

It supports a part of the portion of the zone where the combustion is impeded; but there is always *a reduction in the depth of the zone*, with all the factors this introduces. According to tests made by Piwowarski[2] using a cupola of 18 in. dia., a normal hourly production of 1,210 to 1,430 lbs. was increased to 3,520 lbs. when the blast was preheated to 500 to 580 deg. C. The output of the cupola can thus be increased from 50 to 75 or even 85 per cent. The metal was very hot, in excess of 1,500 deg. C.; the normal coke consumption was increased only by the quantity necessary for the heating of the air. The actual total was 11 per cent.

Action on the Metal.—The iron becomes liquid above the zone of maximum temperature in the region where the melting point is maintained. Very shortly, it drops through a region where the temperature is high, it descends, gradually to be cooled slightly, until it reaches the hearth. Physically it can only become cooler, but the gaseous atmosphere through which it passes is oxidising because of the existence of CO_2 and, in the neighbourhood of the tuyeres, oxygen. It is thus subjected to an oxidation of its constituents Fe, Si and Mn, yielding FeO, SiO_2, and MnO, which pass into the slag, or they may exist, in part, as finely dispersed material in the liquid metal. These substances are more or less reduced in the crucible in the inverse order of the quantities of heat given out on oxidation. The stream, however, has made contact with incandescent coke, which itself reacts on the molten iron, according to the factors set out above. This action is antagonistic to the first, the action on the metal before its arrival at the crucible, and is the algebraic sum of both. This, then, is the noteworthy effect produced by a reduction in the depth of the zone by heating up the blast. According to Piwowarski all these phenomena are attenuated.

Variations in the Depth of the Zone by Alteration in Coke Size.—If the size of coke be changed, the depth of the zone is also changed following the Deville principle. It works out in practice, and it is desirable to study the consequences. They will vary according to the nature of the iron; an iron rich in Si and Mn will heat up itself by increasing the period of oxidation (lengthening of the path). Another, low in these elements will lose (especially) iron, will be cold and sticky. It must not be lost sight of that, in the first case, the situation has been saved by the burning of the Si and Mn, which as fuel are much more expensive than coke. Hence the necessity of a thorough understanding of what happens in the cupola and the relation between what goes in and what comes out so as better to control the cost price.

Third or Reduction Zone

The reduction zone is characterised by the harmful reaction which gives rise to the creation of CO at the expense of the CO_2 generated lower down, *by consuming coke and extracting heat*:—$CO_2 + C = 2CO - 3{,}250$ calories per kg. of carbon. Thus there are both losses in coke and temperature, and most efforts directed towards the improvement of cupola operation envisage the suppression or the reduction of the consequences of this reaction. The reaction is only operative at about 1,000 deg. C., as has been stated, and from it surface limits can be established. At the base it is the surface frontier of the second zone. The upper surface is limited by encountering a temperature at which the reaction is practically negligible. The yield of gases is increased by doubling the volume of the carbon dioxide, as each molecule of CO_2 gives two molecules of CO. The reaction is intense at the base of the zone, in the region of the maximum temperature. It then brings about a marked lowering of the temperature. Its effect, however, is masked, because here it is that the melting of the iron takes place accompanied by a heavy absorption of heat. If the cupola is properly operated, this is what actually happens, but in the limited case where the running of a cupola is so defective that the melting takes place in areas well removed from this spot, things would happen as if the coke was burning to CO and not to CO_2:—$C + O = CO + 2{,}420$ calories per kg. of carbon, instead of 8,080. The extent of the loss is impressive, for the temperature would fall to about 1,300 deg. C.

Boudouard has studied the equilibria which limit this reaction. He has shown that they depend upon time, temperature and the surface condition of the carbon. At 800 deg. C., an hour was necessary to bring about 80 to 85 per cent., whilst at 1,000 deg. C. the reaction was very rapid. But in the cupola the speed of the gases is great. For instance, 100 cub. metres per square metre per minute is blown through, and the temperature expands this volume to seven times higher. The speed thus becomes $700:60 = 11.7$ metres per second. The coke only occupies a portion of the column of the charges, and only the part carrying a temperature exceeding 1,000 deg. C. is active. It is clear, therefore, that Boudouard's figures are not at all applicable in this case, and this also applies to the analyses published by some experimentalists. To simplify the matter, it is proposed to establish the limit of the zone at 1,200 deg. C., as it is thought to be the average melting temperature of cast iron. It is within this region where the most marked perturbation in the temperature curve takes place, and probably near the region where CO ceases to be formed.

Region of Superheating.—This includes the whole zone, since the iron becomes liquid at the lower "frontier," about 1,200 deg. C., and starts dripping from the upper "frontier," which is about 2,000 deg. C. The iron therefore becomes superheated before entering into the oxidising zone, as it is submitted during its passage to the ameliorative conditions of the $CO_2 + CO + N$ mixture, which travels in the opposite direction. The phenomena only differ quantitatively from what happens in the rest of the passage.

Shape of the upper surface limit of the Third Zone—Descent of the Charges.—The lower limit is a concave surface as has been shown. The combustion is accelerated at the periphery consequent upon the more active circulation of the gas, which involves a higher coke consumption in this region and its rapid disappearance. The iron in this area also melts more quickly, since the coke burns more intensively. Thus there is an acceleration in the descent of the charges around the walls of the cupola.

If a vertical section of the cupola is pictured, it can be divided into three concentric regions:—(1) A peripheral region contiguous to the lining, where there is maximum gas circulation, the maximum disappearance of the raw materials and the most rapid descent of the charge. (2) a region intermediate between the central and outer zones, where circulation is moderate and the descent slower; and (3) the central zone where gas circulation and charge descent are the most restricted.

Due to this inequality of speeds of descent in the three regions, it is evident that the alternate beds of coke and iron charged into the throat, initially separated through horizontality, are not long before they assume convexity and progressively become more so as they descend. This implies a movement of the materials from the centre to the outside, with the important result that *the order in which the materials forming the charges were loaded is completely changed during the descent.* There is a tendency for the heavy pieces to go to the periphery, which rapidly loses its coke content, whilst it remains for a much greater length of time in the centre. Here, then, is an indication of the mechanism of the phenomenon of "hanging." It is also germane to call attention to the fact that it is useless to arrange the charges with care as everything becomes upset during their descent. and they will take up the position which efforts have been made to prevent.

The Fourth or So-called Preheating Zone

The last zone extends from the third zone, on which it rests, to the charging door. It plays the part of an exchanger by receiving at the top cold materials, which descend whilst the hot gases pass through the interspaces to escape up the stack. As in all questions of exchange the efficiency of heating depends on the relationship of the calorific masses present. In this case the calorific mass of the gas is incomparably greater than that of the materials, so much so that recuperation will be of limited order.

The existing temperature no longer permits gas reactions, except in a limited region near melting zone. There is, however, by definition, no longer any melting in this zone, and thus little or no gas reaction. The gas no longer effects important chemical changes, but it does act, however, on the solid and hot charges which fill this zone.

Decarburising Action of Gases on the Metal of the Charge.—Contrary perhaps to what one has learnt and maybe still teaches, the gases have no cementation action on the charges, even if they contain soft iron or mild steel. On the contrary, if the gases are devoid of carburising action, *they will have a reducing action on the carburised parts of the charge*, and by decarburising the surface, the melting point of the skin so formed will be raised. The intensity of this action depends on the CO_2 content of the gases.

Action of CO_2 on the Iron of the Charges.—The pieces of hot and solid iron react with the CO_2 on the surface according to the two following equations:—

(1) $Fe_3C + CO_2 = 3Fe + 2CO$.
(2) $Fe + CO_2 = FeO + CO$.

The reaction (1) represents the gas reaction brought about with combined carbon instead of free carbon. The richness of the iron in elements which tend to expel the carbon, the so-called "graphitising elements," will undoubtedly favour refining, whilst "hardening elements" will hinder it.

These two reactions developing on the surface of the pieces a less carburised and therefore less fusible skin, the inside of the pieces melts within this envelope, as soon as they reach the region having the necessary temperature. From this point onwards the liquid interior heats up, until it reaches the region where the decarburised skins will in turn melt and liberate their contents, or are broken by shock or compression, etc., in the journey downwards. Thus it is seen that contrary to established thought, the pieces of iron only start to *melt from the outside where they are free from gas action*, or where they are very quickly melted.

Actually, they melt from the inside, in a refractory skin which is earlier formed. This demonstrates the influence of the duration of the stay in the preheating zone on the formation of decarburised iron, which will then be superheated in relation to the rest when it reaches the crucible, or it will be carburised by the coke through which it passes.

Steel Introduced into Charges.—If steel forms a portion of the charge, it will not be cemented, neither by the gas nor by contact with the incandescent coke. It has been now clearly demonstrated from the interpretation of experiments in the light that cementation is due to the action of drops of liquid iron, which are endowed with a high cementing power.*

(*Concluded on page* 306.)

* The author has been able to establish experimentally the actual formation of a refractory skin by arranging matters so as to avoid breakage. He has been able to withdraw from a melting apparatus working under cupola conditions truncated conical test pieces, which he used for process control. Not only the fracture shows a decarburised skin, which conserved all the grain details, but a hole trepanned for a Frémont test piece was converted into a tube which remained. Two contiguous test pieces in the furnace showing the same degree of transformation were deformed by mutual pressure and emptied of their liquid content through the bottom.

Institute of British Foundrymen

WEST YORKSHIRE BRANCH OPENS NEW SESSION

The winter session of the West Riding of Yorkshire Branch of the Institute of British Foundrymen opened on October 14 with a most encouraging promise for the season in spite of wartime difficulties. The meeting was held at Bradford Technical College in the afternoon, instead of the evening as in peacetime, and there was an excellent attendance. After the meeting the members had tea together, in the College Refectory, as guests of the President (Mr. S. Carter, of Huddersfield).

Presidential Address

Mr. H. A. MacColl presided over the early part of the meeting, which was devoted to an address by the newly-elected President, Mr. S. Carter, who in the course of his remarks said:—

Mr. MacColl and Gentlemen:

The occasion of a Presidential Address is usually marked by a statement of the policy and the aims of the Institute, a pious hope that the coming session will be an improvement on former ones, and an appeal for maintained support and loyalty from the members. While clearly recognising the very great compliment you have paid me, I feel that such expressions, in addition to being superfluous, are neither germane to present circumstances nor in accord with my own temperament. Thus I shall commence by leaving out the recognised perambulations associated with this address.

There is little that a Branch-President can do without the assistance and co-operation of the Council and its Secretary, and I confess that during my membership of the Council I have often likened the passage of an unorthodox suggestion to that usually associated with Parliament when considering a revolutionary Bill. This is not due to a hidebound devotion to set principles or conservatism, but to the genuine desire of all concerned to preserve the character and individuality of the Institute. As recently as last spring I had visions of the adoption of methods which would, if adopted, have resulted in radical alterations in the conduct of our Branch meetings. My chief concern for some time has been the relatively few members who take part in discussions on Papers, and the consequent inertia of the younger and less-experienced speakers who are timorous of expressing themselves publicly. It is also certain that some of our older or better-equipped members feel it incumbent upon them to take part in discussions often upon subjects which could be equally well stated by others with a little encouragement; and while this tendency arises chiefly from a desire to set the ball rolling and encourage the lecturer, it does little, in my opinion, to facilitate the expression of those thoughts locked in the breasts of the slightly less articulate of the members.

While I consider that we owe a great debt of gratitude to those stalwarts among us who take up the cudgels on almost every occasion, it is conceivable that a well-expressed and confident contribution at the beginning of a discussion, from experienced speakers, makes it more difficult for the none-the-less valuable opinions of others to find expression. It had been tentatively agreed upon by the Branch Council that some action would be taken to induce a wider circle of members to contribute to discussions, but as to how far this arrangement can proceed under the new conditions of wartime, with the possible curtailment of meetings, remains to be seen. Should it not be possible to institute some such arrangement during my term of office, I hope the idea will be fostered in succeeding years to the benefit of our members and ultimately of the Institute as a whole.

War Conditions

Peoples who had fought 21 years ago to ensure peace for all time are again contesting the right of might, the subjection of freedom and the subordination of truth for expediency—principles abounding in Germany to-day. Many of the members of this Institute have respected friends in Germany—people whose only wish is for peace and opportunity to follow their occupations and pursuits for the betterment of humanity through the channels of international intercourse and business. Let us then spare a moment of communal thought for those who are made our enemies through no fault of their own, and let us try to retain sanity enough to treat them when the war is over in sympathy with their present difficulties.

Business conditions are likely to be still more difficult and those with responsible positions are having a harassing time. Foremost of all we should remember that progress in our own section of industry is not only vitally essential, but inevitable also, and only by constant contact can we hope to marshal our forces for the national benefit and our own better knowledge. I am confident we shall each and all subordinate ourselves to the measures necessary to the prosecution of the war with a cheerful courage, and I hope that when the black days are over we shall look back with pride on the efforts which we, as an industry, made in the attainment of an objective worthy of the greatest sacrifice.

Vote of Thanks

Hearty thanks to the President for his address were moved by Mr. A. S. Worcester and seconded by Mr. A. W. Walker. Mr. Walker observed that in this session's President the Branch had one of the best organisers he knew. It was unfortunate that circumstances of the time might put an unexpected limitation on the utilisation of that organising ability at the head of the Branch affairs, but if opportunity occurred the members could be sure they had a leader of more than ordinary organising capacity in meeting and overcoming any special difficulties which the war might bring to the Branch.

Leaded-Bronze Bearing Alloys

Mr. F. W. Rowe then gave—in the form of an impromptu lecture illustrated by lantern slides—a *résumé* and commentary on the report of the Institute's Non-Ferrous Sub-Committee on "Three Leaded-Bronze Bearing Alloys." (The report had been previously published in the Foundry Trade Journal.) Presuming that most of his hearers had read the report of the Paper as given at the Congress in London last June, Mr. Rowe dealt with it by way of explanatory analysis for a more intimate understanding of the work of the Committee, leading up to their official Report, and invited questions.

Mr. H. Forrest (past Branch-President) said he felt the Non-Ferrous Sub-Committee had rendered the foundry industry a most valuable service in endeavouring to bring about a limitation of alloy specifications. Any work done to reduce the great many specifications issued by the engineering bodies was to be commended by all foundrymen. There were altogether too many superfluous specifications. As Mr. Rowe had remarked, many engineers fondly imagined they were bound to get a final product strictly in accordance with the test-bar, and an expectation of that sort—having in mind its impracticability—did not help to improve the relationships between the foundry and the engineer.

In answer to a question by the President as to the casting temperature which Mr. Rowe might advise, to get a plate-casting—say, ¼ in. thick—as sound as the test-bar and give the tensile strength required, Mr. Rowe strongly advocated the casting of test-bars separately. If a bar had to be cast integral with the casting proper, they could not guarantee to make both satisfactorily. Every effort, he urged, should be made to persuade customers to regard the test-bar as a criterion of the quality of material in the casting rather than a definite example of the complete casting.

Mr. Illingworth asked what conditions would obtain as to pouring temperature if he were pouring a copper-tin alloy into a certain casting and then used an alloy containing lead.

Mr. Rowe replied that he should use nickel or something else to help depress the casting temperature to stop the lead from segregating. In reply to a question as to the effect of the presence of phosphorus on the coat of the mould, Mr. Rowe agreed that he did not like zinc alloys with a quantity of phosphorus. The higher the phosphorus content the greater the effect on the skin. That was inevitable in any phosphor-bronze.

In reply to another member who suggested the skin was improved if about one ounce of tin were added to a 60-lb. pot and the temperature lowered, Mr. Rowe said he always did put in a certain amount of phosphor tin, but not very much.

In answer to a remark by Mr. Carter that complications might be liable to arise from using an appreciable percentage of phosphorus, Mr. Rowe said there was a good deal of misapprehension about the use of phosphorus, and it was apt to be regarded as a cure-all in foundry practice. That was certainly not the fact. If 0.05 per cent. did not give satisfaction, 0.1, 0.2 or 0.3 per cent. would not do it. Mere increase of phosphorus would never cure bad metal; 0.5 per cent. was about the maximum he would care to use and if trouble still persisted an increase in phosphorus would not help matters.

In reply to a query by Mr. Forrest, as to whether the speaker could recommend anything for covering the metal in the crucible, Mr. Rowe confessed he was not fond of "fancy" coverings for bronze alloys. Given reasonably good melting conditions, he had never found the need for a covering. He did not think it was safe to rely on specifics and "dopes" too much to get good foundry practice. If attention was focused on good raw materials and good conditions, he did not think cure-alls were necessary.

In reply to another member, Mr. Rowe said he did not approve over-heating the copper before adding tin or lead. "Stewing" the metal or over-heating would introduce troubles of other kinds. The lower the temperature could be kept the better.

Hearty thanks were accorded Mr. Rowe, on the motion of Mr. Walter Fearnside (Keighley), seconded by Mr. H. Coggan.

The meeting unanimously approved the holding of Branch meetings on Saturday afternoons, instead of evenings, during the wartime blackout.

Bellfounders turn Gunfounders

By ERNEST MORRIS, F.R.HIST.S.

Bellfounders have not always followed the craft of turning out bells only, for in mediæval times when church and other bells were not so frequently used they turned their attention to other fields. Thus it is well known that bellfounders followed other branches of metal industry, turning out pots, lavers, mortars and even guns. As is well known, bell-metal is very similar to what was known as gun-metal before the invention of ordnance first of cast iron, and then, as we have it to-day, of steel. There are numerous instances of the metal being cast, first in one form, then in the other. In Russia, Peter the Great is said to have converted church bells into cannon, and the great bell of Rouen was put to a similar purpose in 1793. During the European War (1914-18) the Austrian Government consigned to the melting pot the great bell of St. Stephen's, Vienna, which was cast in 1710 at the command of Emperor Joseph I from the metal of 180 cannon captured from the Turks. This bell weighed nearly 18 tons. Another great bell cast from French cannon captured during the Franco-German war and weighing over 25 tons was placed in Cologne Cathedral in 1874. This also was removed during the Great War (1914-18) and melted down for munitions to be used against the French, even as it itself had been mainly cast from French cannon. In 1925 a new bell was placed in Cologne Cathedral to replace the former one, and of about the same weight.

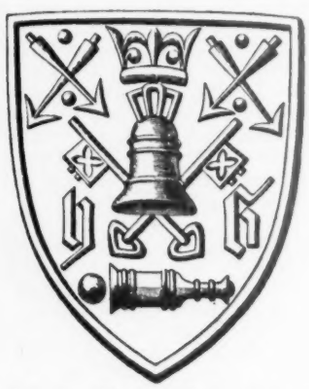


FIG. 1.—MARK OF BELLFOUNDERS OF BURY ST. EDMUNDS.

In the earlier part of the same war, the Russians removed many bells from the war areas, and it is well known that both Belgium and France suffered the loss of many church and other bells, all evidently taken away and used for the making of armaments. On the other hand, there are instances of cannon being used in the casting of bells, and here in England at Liversedge, Yorkshire, is a bell inscribed:—

"These eight bells were cast in 1814 and 1815 with brass ordnance taken at Genoa" and a Latin couplet adds:—

"The tyrant overthrown, Europe freed, the peace desired now for twenty years agreed upon—Praise to God—1814."

In Henry VIII's time, the exportation of bells and bell-metal became a criminal offence. An Act was passed which read: "Noe p'son or p'sons shoulde from thenceforthe carrye or convey any brasse, copper, laten, bellmettall, gunemettall, ne shroffe mettall into anye part or parts beyonde the sea upon payne of forfeyture of the said mettall." It is possible that this law was to prevent bell-metal being purchased by unfriendly foreign powers who might convert it into ordnance to be used against us. There were, of course, enormous quantities of bell-metal for disposal after the dissolution of the monasteries at this time.

The Bury bellfounders used as their foundry mark—which was passed on to successive proprietors—an elaborate shield bearing a crowned bell, the keys of St. Peter, the crossed arrows, symbolic of St. Edmund (St. Edmundsbury) and a cannon with ball (Fig. 1). In addition are the initials H.S. of a 15th Century founder who combined the craft of gunfounding with that of bellfounding, like many other members of the foundry trade. An instance of this is shown in the activities of Robert Mot who founded the now famous Whitechapel Bellfoundry as long ago as 1570, in that he cast cannon for Queen Elizabeth's ships of war at the time of the Spanish Armada. We have an instance of a bellfounder who was unfortunately killed while casting cannon. He was Matthew Bagley, one of a famous family of bellfounders of Northants, who, migrating to London, acquired the foundry of Philip Wightman. The tragic manner in which he lost his life is thus described in the "Flying Post" of May 12, 1716:—

> "Last Thursday night about nine oclock, a tragical accident happened at the Royal Foundry near Upper Moorfields, where, when the workmen were casting a cannon, the metal that was running into the mould flew up on a sudden with great noise and violence, and came down like drops of fire, not only upon all the workmen, but spectators (of whom there was a great number to see the performance). Several attended from the Tower, particularly Mr. Hall, Clerk of the Ordnance, who was sorely wounded that he dyed next morning. The Master Founder and his son with above twenty others, were also very much hurt. 'Tis generally agreed that the said accident was owing to the dampness of the mould."

The "Weekly Journal" of May 12, 1716, further states that "Bagley, the Master Founder, has lost his eyes, and his son and sixteen others are desperately wounded." Both Bagley and his son died of their injuries as the Registers of St. Giles, Cripplegate, shows:—

1716 May 22.—Matthew Bagley, Founder, killed.

May 26 Matthew Bagley, Junr., killed.

Welding Aluminium Castings*

When welding aluminium alloy castings special precautions are sometimes necessary, due to the intricate design and varying section thickness of the castings, which make them more sensitive to thermal strains and cracks. A large number of castings are supplied in the heat-treated condition, and welding these castings will partially destroy the effect of the heat-treatment. Unless facilities are available, therefore, for re-heat-treating the castings after welding, welding of such castings is not recommended.

Of the various casting alloys, the aluminium-silicon group are the easiest to weld, followed by the aluminium-copper group. The aluminium-magnesium alloys are the most difficult to weld satisfactorily.

Preparation for Welding

Aluminium castings which have to be welded should first be cleaned carefully with a wire brush and petrol or other solvent to remove every trace of oil, grease and dirt. In cases where the castings have become badly impregnated with oil, it would be advisable to degrease first in trichlorethylene, then electrolytically in a caustic solution, followed first by a wash in a 5 per cent. solution of sulphuric acid, with a final thorough washing and rinsing in hot water.

Unless the casting has a very heavy cross-section, it is not necessary to tool the crack or cut out a vee. This can generally be accomplished by means of the blowpipe and puddling iron. It is necessary, however, that the stock surrounding the defect be completely melted or cut away before proceeding with the weld. If a piece is broken out, it should be held in correct position by light iron bars and appropriate clamps. The clamps should be so attached that the casting will not be strained during heating. If the casting is a large one with intricate sections, it should be pre-heated slowly and uniformly to between 370 and 430 deg. C. in a suitable furnace prior to welding. If the casting is small, or if the weld is near the edge and in a thin-walled section, the casting may be pre-heated in the region of the weld by means of a torch flame.

Broken pieces should be tack welded into place as soon as the casting has been pre-heated. The actual welding should commence at the middle of the break, and welding should be done towards the ends. The welding rod must be melted by the flame as the heat of the molten metal is not sufficient to melt it.

When the weld is finished, the excess molten metal should be scraped off with a puddling iron, and the casting allowed to cool slowly. Holes in castings are welded in much the same manner as are cracked and broken castings. It is necessary to melt away or cut away the sides of the hole in order to remove all pockets and to permit proper manipulation of the blowpipe.

For welding ordinary castings the 5 per cent. aluminium-silicon alloy, or an aluminium-copper-silicon alloy welding rod is generally used. However, in the case of heat-treated castings, a welding rod of the same alloy as the castings is to be preferred and can often be used satisfactorily.

Fluxing Necessary

A flux should be used when welding aluminium alloy castings. Puddling alone will merely break up the oxide film and leave it incorporated in the weld, while fluxing will cause the oxide particles to rise to the surface, producing a clean, sound weld. It is important

(*Continued in previous column.*)

* From details supplied by Aluminium Union, Limited.

(*Contined from next column.*)

that the added metal be completely melted, and the molten metal thoroughly worked with the end of the welding rod or with a puddling iron, to enable the flux and oxide to come to the surface of the molten metal.

In the welding of large castings in which the area to be welded is quite large and easily accessible, welding rod is often dispensed with, and the molten metal added directly from a small ladle, using metal of the same analysis as the castings.

Poured welds are recommended for filling large holes and cracks. A form of jig of fire clay, plaster of Paris, or metal is fitted around the hole or crack. After the casting has been pre-heated in a suitable furnace, the flux is brushed on the faces to be welded and the area to be welded is held at the proper temperature by means of a torch. Molten metal at not over 710 deg. C. is then poured into the weld, the flux and included oxide will immediately float to the surface and can easily be skimmed off.

Phosphor-Bronze Castings of Heavy Sections

By A. HOPWOOD

(*Continued from page 287.*)

Mould Materials

As sand suffers less from deterioration due to lower temperatures and the protection of good mould blacking mixtures, it is only necessary to use a facing mixture on the bottom face, the rest of the mould being rammed in floor sand. The facing mixture is a very open regular grained sand, drying well and withstanding very close ramming. It may advantageously consist of 30 red sand, 10 road sand (high silica), 10 horse manure or sawdust, and 50 per cent. heavy floor sand. The use of metal parts in moulds not only offers greater resistance to liquid pressures than sand, but involves the rapid expansion of the chill face when in contact with the solidifying metal which compresses into the pasty mass. This can be visualised by observing the metal in the riser; after an initial rise there follows the usual sink.

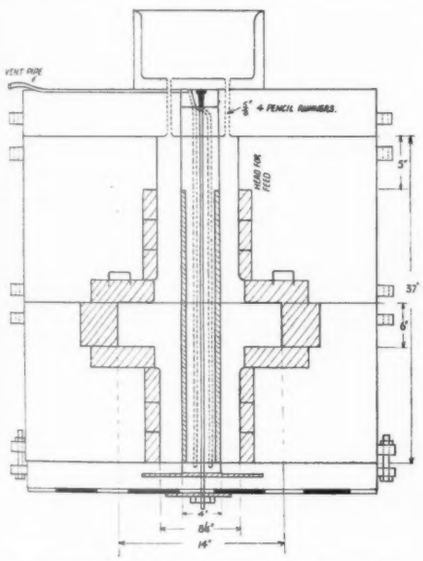


FIG. 10.—MOULD FOR WORM WHEEL AND NUT.

The operation of ramming "soft" in places where scabbing is expected should not be tolerated, not only on account of the danger of a swollen casting, but also because mould gases on expanding will take the easiest path, which is through this open, weakly rammed sand, into the metal. This does not always show itself by blowing up the risers, as the gas may come away in a gentle stream and not by explosive force.

Progressive Solidification

Progressive solidification is so controlled by the method of running and the time that the mould takes to fill, that it is worth serious attention. The ideal condition is that the casting should commence to solidify from the bottom upwards, the risers or feeders remaining liquid to the last. This requires that the hottest metal should be in the highest portion of the mould. Thus the top running of moulds helps this to a large extent, but is not always applicable owing to design and method of moulding. When one has to resort to running in the lower parts of the mould, particular care must be paid to see that (1) the metal must enter without striking the mould or cores and at as great a number of inlet gates as possible, so as to minimise the formation of hot spots, giving localised slow cooling; and (2) the mould should fill as quickly as possible so that the difference in the temperature of the metal is as little as possible between the bottom of the mould and the top.

When the casting temperature is as low as possible, there is also the danger of cold laps. The application of hydrostatic pressures as quickly as possible, driving the gases away from the casting, is also an inducement to the rapid filling of the mould. The gating system of many large-sectioned moulds requiring an alloy of long solidification range, and therefore to be cast at as near as possible to the upper limit of that range, demands that they be run quickly and smoothly with a maximum number of controlled gates. Moreover, one must employ some method at the bush for it to be kept full of metal, so that no dross or charcoal can pass into the gating system and may be drawn by the metal into the casting.

Pouring Conditions

Filter cores are not sufficiently fast for the larger and heavier castings, and any speeding up of the filter increases the danger of the collected dross, etc., entering the casting if the pourer halfway through the cast fails to keep the bush full. The use of a reservoir or pouring bush which will hold about half the metal required for the cast, and in some cases more, removes much of the personal element from the casting period. The metal is held in the reservoir by the plug and sealing system, the plug being drawn when sufficient metal has been introduced. The practice of keeping the reservoir above the risers and down gates is economical, as all the metal poured into the reservoir bush passes into the mould and is used. Moreover, it deteriorates but little and can be reused. With due care and attention at the plug seating, it will last for weeks.

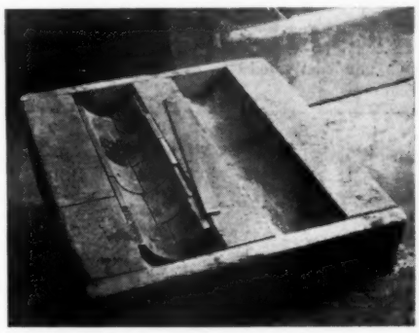


FIG. 11.—METHOD USED FOR MAKING CHILLED CORES.

The speed with which the metal leaves the basin is governed by the size and number of ingates. These are particularly important when the reservoir basin is added after the top has been closed down. If the metal leaves the basin far in excess of the amount which the ingates can take, there is always the danger of a "burst away" where the basin sits on the down-gate entrance.

As the casting temperature is as low as possible in relation to everything else, any leakage of metal through the plug and seating will trickle into the runners and set, and so restrict the entrance of the metal when the plug is drawn, and in very bad cases may completely seal it. The deepening of the runners in the vicinity of the down runners obviates the danger of a complete blockage. The general arrangement of the mould for a worm wheel and nut is shown in Fig. 10. This arrangement does not offer any great difficulty as to moulding, but the production of this casting in a high-tin phosphor bronze requires special attention and technique. The depth of cut with ¼ in. outside and 1 in. cut for the teeth gives a total of 1¼ in. on the wheel section. The inside worm thread has a total metal removal to the bottom of the thread of ⅜ in.

The difficulty of producing this casting with no visible porosity will be appreciated, as there is the slow cooling due to mass, coupled with deep machine-cuts into the metal. To overcome this slow cooling which would take place in an ordinary sand mould, the sand can be replaced with some material which has a greater conductivity of heat, which in the author's case was standard cast-iron rod. Then to regulate the cooling as much as possible, the cooling must be speeded up at the heavy section to bring it into line with the two shank parts. Therefore, the chills are a great deal heavier at that portion. The chills are not continued into the head, as this part is required to solidify last.

FIG. 12.—CASTING FOR WORM GEARS WEIGHING 6¼ CWTS.

The thicknesses of the chills are 4 in. for the centre section, 2 in. for the top and bottom chills on the same section; 1½ in. for the bottom shank; and 1¼ in. for the top. These differences were made to induce progressive solidification.

Core Details

The core was chilled by cast-iron quarter-segment chills ⅜ in. thick up the casting only. In the making of the core, due care was exercised to maintain an unbroken chilled surface. If this is not observed there is a danger of a contraction crack or hot tear showing, or a porous area due to the relative slow cooling and different rates of contraction and shrinkage and liability of eutectic migration. All joints are carefully made up, two good coats of dressing being applied. Any slackness in the making of the joints of the chills will have their repercussion in the fettling shop as there will be a difficulty in removing the chills. There is a tendency for

the metal to search into the weak joints in the same manner as it does in weakly rammed moulds, holding the chills into a solid mass. The running and gating was by four ⅜-in. dia. pencil runners set on the top of the head so that the metal passed down the centre of the metal section, care being taken to see that all four were perpendicular, so that the metal in dropping would not strike any of the metal parts of the mould, thereby inducing local over-heating with its attendant troubles. For the same reason the mould on assembly must be set perfectly upright. The metal was cast at 1,040 deg. C., the pouring bush being rapidly filled. Due to the open nature of the pencil runner no stopper or plug was used.

FIG. 13.—HEAVY SECTIONED CASTINGS TYPIFYING SUBJECT UNDER CONSIDERATION.

The metal was first carefully skimmed while waiting for the correct casting temperature.

During the casting period of any mould mixed gases are generated which may deposit moisture on the cold chills, causing a disturbance when the metal comes in contact with them. Chills hanging in the top or middle parts can with advantage be closed warm to hot, depending on their relationship to everything else, thus minimising the condensation of moisture.

Examples from Practice

Fig. 11 shows one method used for making small-diameter chill cores or for that matter any diameter where a half core-box is available. The segment chills are laid in position in the box and then rammed up in the ordinary way, provision being made for holding them in position

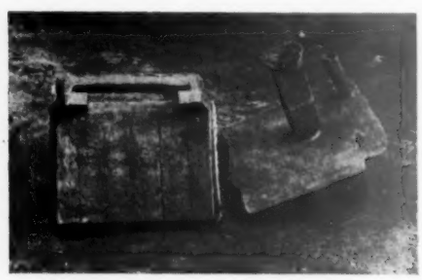


FIG. 14.—PAD CASTINGS DIFFICULT TO MAKE.

by spring or wire through a tapered hole drilled in the chill. The use of any material to increase the adhesion of the sand to the chill which will form a large volume of gas on casting should be avoided and the chill face should be continuous in order to avoid shrinkage and structural faults.

A worm cut from the solid casting with a cored hole of 3¼ in. dia. with outside machining allowance of $\frac{3}{16}$ in. and ⅛ in. in the bore involves difficulties in production. It should be realised that after the casting has been machined to its outside finished diameter, the worm has to be cut, which entails the removal of 1.91 in. of metal and it must show no porosity or openness of grain on inspection. The ordinary sand-cast methods, no matter how low the casting temperature, would not produce a satisfactory casting. The slow cooling of the mass and the difficulty of feeding over such a length of time would in all probability lead to open metal. The outside was chilled by segments 2 in. thick, the bore being chilled as shown previously. The head on the casting was increased to 2 in. as no quick cooling was required. The mould was rammed as hard as possible at the back of the chills with floor sand which would just hold together, and facing sand was only used on the bottom. It was top-run with four ⅜-in. dia. pencil runners, the mould completely dried and almost cold when cast, the metal being poured at 1,020 deg. C. The alloy used was 12½ to 13

FIG. 15.—ADJUSTABLE WEDGE CASTING WEIGHING 23 CWTS.

per cent. tin, 0.25 to 0.3 per cent. phosphorus, the remainder being copper. Fig. 12 shows such a casting after fettling; it weighed 6¼ cwts.

Fig. 13 shows a group of castings typical of the general thickness of the castings under consideration. The total weight of those illustrated is 22 cwts. Fig. 14 shows a very simple casting which can easily lead to a good deal of trouble

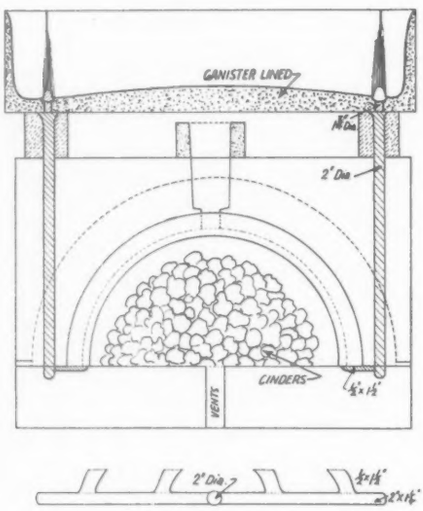


FIG. 16.—MOULD FOR SEGMENT PIECES.

and expense in machining. These castings are pads which support the large cast-iron spindles in tube-boring machines, wherein the spindle weighs up to 18 tons. The machining of these pads to correct radius is by setting the full series on a machine table, the lugs being used for this purpose until they are parted off on the last operation. The riser should, if possible, be placed on this part of the casting. It was decided to chill the bottom face, as-cast, which is, of course, the bearing face, for three reasons: (1) to obtain a fine structure, giving satisfactory Brinell hardness and density; (2) to minimise the danger of any of them showing open metal due to the machine operator setting some of them so that there is a heavy cut off the bearing face, and (3) the expense and difficulty of machining odd replacements for any reason.

The chilling pads are placed on the pattern before ramming up, and then nearly dry floor sand is rammed firmly behind to maintain them in position.

Fig. 15 shows an adjustable wedge piece for a large bearing weighing when complete 23 cwts.; there are four pieces to the set, that is two segments and two wedge pieces. It is cast in phosphor bronze of 12 per cent. tin, 0.20 per cent. phosphorus, the remainder being copper. The casting must show on the bearing faces after machining a minimum of 80 Brinell. Fig. 15 shows the partially fettled casting with spray runner for distribution of molten metal and two end risers passing the end flanges so as to feed into the main body of the casting. Fig. 16 shows a sketch of a complete mould for the segment pieces, and is typical of the method employed for all half steps. The distribution of metal by sprays on both sides is used, the pouring bush being used for the heavier casting, that is those weighing over 2 cwts. Smaller castings utilise fast filter bushes. The moulds are well rammed, no soft ramming being permissible on the bearing face. The cinders are very tightly packed so as properly to support the face of the mould on casting. The chief reason for the introduction of the cinders is to ensure a quick and thorough drying of the bottom part. There are two main vents leading from the cinders to the atmosphere, and the casting temperature is of the order of 1,050 deg. C.

The author wishes to express his thanks to Mr. E. Longden (foundry manager) and to Mr. E. L. J. Howard for the help given in the preparation of this Paper, and to the directors of Craven Bros. (Manchester), Limited, for permission to publish the data disclosed.

Metal to Rubber Joints

MR. F. H. COTTON, writing in the "India Rubber Journal," describes the Vulcalock process for bonding metal to rubber after a double coating with 10 per cent. solution of thermoprene in benzene. This is made by treating rubber with sulphuric acid or naphthalene sulphuric acid. This bonding material is allowed to become practically dry before placing the rubber in position, when it becomes vulcanised in contact with the metal. There is good adhesion providing the assembly be cooled under pressure. A cement recommended for affixing rubber to aluminium consists of:—Hemoglobin, 100 grms.; water, 300 ml.; sulphur, 45 grms.; zinc oxide, 5 grms.; D.P.G., 1 grm.; 30 per cent. latex, 575 ml.; formaldehyde, 10 ml. of 10 per cent. solution. A clean metal surface is essential, associated with a thick layer of the latex cement. After drying for an hour at room temperature, it is baked for two hours at 120 deg. C. The surface is then roughened by scratch-brushing, and a rubber stock solution is applied using a cement in the ordinary way. Finally vulcanisation of the assembly completes the process.

Aluminous cement of the *ciment fondu* type mixed with concentrated latex is often successfully used as a bond in connection with steels having cleaned surfaces.

Absolute Hardness

E. G. MAHIN and G. J. FOSS in "Trans. Amer. Soc. Met." describe a method for the determination of the absolute hardness of metals, in which a hemispherical recess is drilled into the surface of the metal with the same diameter as the testing ball and the hardness given by the maximum load on the ball which produces no measurable enlargement of the drilled recess divided by the projection of the spherical surface.

British Cast Iron Research Association

ANNUAL REPORT OF COUNCIL FOR 1938-39

This Report, an extract from which is printed below, was presented to the annual meeting of the Association held yesterday at the Queen's Hotel, Birmingham. The Report, for the sake of economy, is of a somewhat abbreviated character

Council and Officers

The eighteenth annual general meeting was held in London on September 15, 1938, followed by the annual luncheon. The honorary officers were re-elected, and Mr. H. B. Weeks, F.I.C., chairman of Council for many years, was elected an honorary member. The Council re-elected Dr. Harold Hartley as chairman, with Mr. P. A. Abernethy and Mr. J. B. Allan as vice-chairmen. During the year four meetings each of the Council, Research Committee and Publications Committee have been held. Dr. J. E. Hurst was re-elected chairman of the Research Committee, and Mr. T. M. Herbert chairman of the Publications Committee. Of research sub-committees and other groups, forty-two meetings have been held during the year. The eight research sub-committees remain unchanged and there are, in addition, the Joint Committee on Vitreous Enamelling with The Institute of Vitreous Enamellers, the Joint Committee on Sand Testing and the Sub-Committee on the Weldability of Cast Iron in collaboration with the Institute of Welding. A new committee, formed in March to deal with problems relating to A.R.P. in foundries, has been active, and Mr. P. H. Wilson has acted as its chairman.

Reports and Publications

The research and development programme continues, subject to the changes referred to below. Since the beginning of the year under review, fifteen printed research reports and eight typescript research reports have been issued. An index to all publications, covering the period 1937-39, has been prepared and distributed to members.

Research reports, issued confidentially to ordinary members only, will in future be termed Association Reports. The printed series will be known as Series A and the typescript series will be known as Series B, but the number series will not be changed. The reports hitherto known as Bureau reports, from the Library and Information Bureau, non-confidential in character, will be termed External Reports. Of these, twenty-three have been issued during the year, together with twenty-four translations of important foreign Papers. Since the end of the year three reports, previously issued as confidential to members, have been issued for general use as Special Publications, Nos. 3, 4 and 5. These concern A.R.P. for cupola furnaces, the hardness testing of chilled rolls and the pig-iron grading scheme evolved by the Pig-Iron Sub-Committee.

Nine members of the staff gave fifteen lectures and Papers to scientific bodies during the year, and in addition two Papers were contributed in scientific journals. The Papers presented included "The First Report of the Research Committee on High-Duty Cast Irons for General Engineering Purposes," presented by the Director to the Institution of Mechanical Engineers in December, 1938; two reports to the Iron and Steel Institute on the estimation of non-metallic inclusions, by Mr. E. T. Austin; the Paper by the Director and Dr. G. T. O. Martin to The Institute of Vitreous Enamellers on "Scientific Aids to Control in Vitreous Enamelling," and two Papers presented to the International Foundry Congress in June, 1939. A Paper by the Senior Metallurgist on "The Effect of Casting Temperature on the Primary Microstructure of Cast Iron" was accepted for presentation at the autumn meeting of the Iron and Steel Institute (subsequently cancelled by the outbreak of war) and has been published by that body, and another has been accepted for publication by the Institute of Metals.

Library and Information Bureau.—During the year 472 accessions were made to the library, and there were 1,872 loans. No fewer than 368 inquiries were dealt with exclusively by the library.

Development Department and Laboratories.—The Development Department during the year dealt with 1,540 inquiries and practical problems from members, sent to Falkirk and Birmingham. Laboratory activities were fully maintained, both at headquarters and at Falkirk. The chemical laboratories completed over 13,000 duplicate estimations and the mechanical testing laboratories over 3,500 tests. In the microscopic laboratory 1,500 micro examinations were made and in the sand-testing laboratory over 2,100 tests were made on sands and refractories. In the experimental foundry 660 melts were carried out.

Scottish Laboratory.—The Scottish Laboratory has continued its activities under Mr. T. Tyrie, B.Sc., and in October, 1938, a very successful study course was arranged in Glasgow, for which over seventy members registered.

Research and Development

The problem of securing irons of fine or supercooled graphite structure from the cupola furnace has been attacked from a new angle, and it is hoped that this will enable this very obstinate problem to be cleared up. It has also been established that this type of structure is extraordinarily free from internal porosity or shrinkage. Some interesting confirmations of the work accomplished to date on this subject have been received from external sources. The methods developed for estimating non-metallic inclusions are being applied to a very representative range of British pig-irons, and other work done in conjunction with the Iron and Steel Industrial Research Council on ingot moulds is reported in the Second Report of the Ingot Moulds Sub-Committee, which forms Section VIII of the Eighth Heterogeneity Report of the Iron and Steel Institute. This work is being continued.

The investigation on shrinkage and contraction has provided specific limiting figures for carbon, silicon and phosphorus, within which castings made in the test-piece adopted may normally be expected to be free from porosity, and three reports have been issued to members during the year. The preliminary results of the work on high-duty irons were reported in the above-mentioned Paper to the Institution of Mechanical Engineers. The report was fully discussed and well received, and the work has been actively continued.

During the year the research work on heat-resisting alloy cast irons containing aluminium has been completed and development has been in active progress. Unfortunately the outbreak of war has rendered it impossible to obtain aluminium except for priority requirements, and, as a consequence, the work has been closed, although as and when opportunity offers the aluminium cast irons will be recommended for use in suitable applications.

On enamelled cast irons much preliminary work has been done. A highly successful vitreous enamelling study course, the first of its kind, for which over one hundred registered, was held at the end of May. A complete bibliography of articles and Papers on vitreous enamelling has been prepared and a regular issue of **Enamelling Abstracts**, separately from the Bulletin of the Association, has been begun, the first issue being made in July, 1939. A standard test for chemical resistance of enamels to attack has been evolved and systematic visits have been paid to over thirty enamelling plants all over the country.

The investigation on melting practice has reached a stage of completion by the issue of a research report on the factors affecting blast volume and pressure, and three other reports in this field have also been issued. The number of balanced-blast cupolas installed or under construction has reached 211, capable of an hourly output of 1,550 tons.

The work on moulding sands has been mainly confined to a complete examination of standardised tests and this has engaged the full attention both of the Sub-Committee and the Joint Committee on Sand Testing. The standard B.C.I.R.A. apparatus for compression testing and permeability has been re-designed and improved.

A preliminary programme related to the welding of cast iron has been worked out with the Institute of Welding and is now in progress.

With respect to the responsibilities of other sub-committees, six reports have been issued on methods of testing and on specifications, and two on pig-iron grading. Proposals for the revision of existing British Standard specifications for malleable cast iron have been under active consideration and a standard method for determining the hardness of chilled rolls has been issued.

Education

British Foundry School.—The fourth session of the British Foundry School was completed in August, 1939, the list of successful diploma students being the largest in the history of the school. Following the outbreak of war, the Governing Body decided to close the school until further notice, as all prospective students have had foundry experience which could be utilised during the emergency on productive work.

A student of the school for this session, Mr. E. J. Ludlow, was awarded the first of the Fellowships offered by the Worshipful Company of Founders, valued at £250 per annum.

Finance and Membership

BUILDING AND EQUIPMENT FUND TO JUNE 30, 1939

	£	s.	d.
Birmingham Electric Furnaces, Limited, Birmingham	128	0	0
Bradley & Foster, Limited, Darlaston	52	10	0
Brightside Foundry & Engineering Company, Limited, Sheffield ...	13	17	3†
Crane, Limited, Ipswich	25	0	0
Wm. Cumming & Company, Limited, Glasgow	30	0	0
Davis & Baird Pty., Limited, Melbourne	5	5	0
Ealing Park Foundry, Limited, London	5	5	0
General Industries, Limited, Melbourne	35	0	0*
Hongkong & Whampoa Dock Company, Limited, Hongkong ...	15	15	0*
The Horsehay Company, Limited, Wellington, Salop	4	10	0†
Mason & Porter, Limited, Auckland	21	0	0
Mirrlees, Bickerton & Day, Limited, Stockport	31	5	0‡
Parsons Marine Steam Turbine Company, Limited, Wallsend-on-Tyne	5	5	0*
Round Oak Steel Works, Limited, Brierley Hill	20	0	0
	£392	12	3

* First instalment. † Second instalment. ‡ Second and third instalments.

Accounts.—The accounts show a total income for normal purposes of £17,505, with a credit balance over expenditure for the year of £1,016. Of the expenditure, £708 was expended on plant, equipment and accommodation. In addition, £393 was received for the Building and Equipment Fund, opened by the President and referred to in the last report. Details of the contributions are on page 305, and the Council takes this opportunity of thanking contributors very warmly for their interest and practical assistance.

At the close of the year the number of ordinary and trade members was 354 and associate members 52. This represents an increase over the previous year.

Relations with Other Bodies

As in previous years, close relations have been maintained between the Association and a number of other associations and institutions.

Dr. J. E. Hurst, chairman of the Research Committee, was awarded the honorary degree of D.Met. of the University of Sheffield, and was elected chairman of the International Committee on the Testing of Cast Iron.

At the International Foundry Congress in June, 1938, the Director was awarded the Oliver Stubbs medal of the Institute of British Foundrymen.

Grant Aid

The year ending June 30, 1939, was the last year of the quinquennium with respect to grant arrangement with the Department of Scientific and Industrial Research. The Council applied for a continuation of grant and presented a memorandum on the Association's work. The laboratories, staff and work of the Association were officially visited and inspected by a group of the Industrial Grants Committee of the D.S.I.R., Viscount Falmouth acting as chairman. This Committee visited the laboratories on December 7, 1938, and subsequently a deputation of the Council saw the Industrial Grants Committee in London. As a consequence, the block grant of £5,000 received for the past five years was offered for the five-year period commencing July 1, 1939, subject to the Council raising from the industry the sum of £8,000 per annum in subscription income, instead of £7,000, as previously. The Council was further encouraged to secure more by an offer of additional grant up to £3,500 per annum, subject to raising additional subscriptions to the same amount, making possible a total income of £20,000 per annum, conditional on the industry subscribing £11,500 per annum. The Council accepted this offer, which means that in order to maintain current activity, the subscription income from the industry has to be increased by £1,000 during the current year, but the Council naturally desires to see the whole of the grant offered fully earned. This would entail an increase in subscription income of over £3,000 per annum.

Effect of the War

The Council takes this opportunity of congratulating the President, Lord Dudley, on his appointment as Regional Commissioner for the Midland region, under the national defence arrangements.

Although war was declared after the year under review closed, the Council takes this occasion to indicate briefly the effect of war conditions on the Association's work. In accordance with arrangements made with the Department of Scientific and Industrial Research, the Association continues its normal activities and will act as an organised scientific unit and a central scientific agency for the industry, and the services normally rendered to members will be continued. Under this arrangement senior members of the staff are registered in the index of scientific specialists at the Ministry of Labour and cannot be removed without the permission of the Department.

As the industry changes over from peacetime to wartime activities and adapts itself to the latter, it is obvious that there will be considerable calls on the services of the specialist staff for assistance. It may be recalled that the research associations were founded after the last war in order that in future industries should not suffer from certain technical deficiencies which were revealed during that period.

Executive Committee

In view of the difficulties surrounding attendance at meetings, although it is not intended to abandon meetings of the Council, committees and sub-committees, the Council has appointed an Executive Committee to act in matters requiring emergency decisions. This comprises Dr. Harold Hartley (chairman of Council), Mr. J. B. Allan (vice-chairman), Dr. J. E. Hurst (chairman, Research Committee), Mr. T. M. Herbert (chairman, Publications Committee), and Mr. P. H. Wilson (chairman, A.R.P. Committee). The Scottish Laboratories will be similarly served by a committee comprising Mr. P. A. Abernethy (vice-chairman of Council), Mr. G. A. Ure (chairman, Scottish Committee), and Mr. J. Arnott (member of Council). Matters affecting the sub-committees will be dealt with by their respective chairmen.

The Association is acting, at the suggestion of the Home Office, through its Anti-Glare Committee, as a body approving of schemes for eliminating glare in foundry furnaces, in accordance with the requirements of the Civil Defence Act, and the Association's development staff has already dealt with a number of these schemes. About 1,500 copies of Special Publication No. 4, A.R.P. for cupolas, have been distributed, and a second edition is contemplated.

The Association has taken active steps to ensure the provision of suitable work for the industry as a consequence of the war, and has also assisted various departments of H.M. Government in their requirements. The A.R.P. Committee has evolved a design of trench lining, built of flanged cast-iron plates, complete with floor and roof, and its chairman, Mr. P. H. Wilson, has placed at the disposal of the industry, through the Association, a special design of anti-glare device for cupolas. In view of the importance of the industry speaking with a united voice to the various controls now instituted, the Association has taken part in promoting the formation of the Ironfounders' National Committee, and the Council has approved of the Director acting as its honorary secretary.

The Cupola and the Melting of Iron

(*Concluded from page* 300.)

Steel thus descends as such until it meets the region where the temperature is sufficiently high to melt it. It becomes cemented in the course of its passage by contact with the coke, and the same preceding factors will govern the extent of this carburisation. It should be stressed that there is no cementation in the solid state by direct contact of the coke and the steel, both being incandescent, because the time factor is insufficient and the contact is pretty poor. Practically speaking, there is no action.

REFERENCES.

[1] Seigle and Girardet, Micrographic Observations relating to the Cementation of Small Balls of Steel by Liquid Iron. 18th Industrial Chemistry Congress, Nancy, 1938. Paper No. 3.

[2] E. Piwowarski, Die Giesserei, 1939, p. 169.

Supplies for National Purposes

PRINCIPLES GOVERNING PRIORITY

A memorandum setting out the principles which govern the system of priority in regard to supplies for national purposes in amplification of the Priority of Works Order, 1939, has been issued by the Ministry of Supply.

It is pointed out that in the field of manufacture and supply the national effort must be directed to the following ends:—(*a*) The equipping and maintenance of the Armed Forces; (*b*) the maintenance of essential national services; (*c*) the maintenance of sufficient export trade to produce enough foreign exchange and as far as possible of our internal trade also.

It would be impossible, even if it were considered desirable, to lay down a hard and fast order in which these three requirements should be met, because they are all required to bring the war to a successful conclusion.

As regards the direct requirements of the Government in the immediate future, the available industrial capacity has to a large extent been surveyed and the output of certain firms has, with their agreement, been allocated between Departments. This is a framework on which to place present orders, but additional capacity is required, and it is intended to continue the practice of allocating capacity in suitable cases. Firms will be informed of allocations when made, and those firms whose capacity is allocated should be able to rely upon as long a run as possible of a particular product or products and so avoid the waste of effort entailed in changing from one line of production to another.

There has been a good deal of misapprehension in regard to the issue of priority certificates, which may be due to the fact that, in 1917-1918, a "Priority Certificate" was usually required before any work could be done or materials obtained. If priority certificates become necessary during the present war the system under which principal and subsidiary priority certificates are to be issued and the classes into which priority orders are to be divided are those set out in the Priority of Work Order, 1939. But this general system of priority has not yet become necessary, and it is not at present intended to issue priority certificates on any substantial scale, because a general issue now on the scale obtaining during the last war would merely lead to delay and tend to upset the even flow of production which is essential for the efficient prosecution of the war.

Power to Issue Certificates

To the extent that the system of granting priority certificates under the Priority of Work Order, 1939, is brought into operation, the only authorities who will be empowered to issue them are the Government Departments concerned. No other certificates or directions purporting to be of a "priority" nature can be properly issued or legally enforced.

The supply of raw material is in some instances under control. There is no general shortage of raw materials. If there is any difficulty in this direction application should be made to the appropriate control for assistance. Controllers have been instructed to give preference to the allocation of materials where reasonable information can be provided to show that the materials are needed for Government work or for work on essential national services.

As a very general guide, and having regard to the foregoing observations, the following summary is given:—

(*a*) Other things being equal, orders should be carried out in the order in which they are received.

(*b*) Difficulties in regard to raw material should be referred to the Controller concerned.

(*c*) *Priority certificates having legal force will only be issued when necessary by order under the direction of the Government Department concerned.* The appropriate department will be the department placing the order under execution (or the main contract from which a sub-contract has issued); or the department generally responsible for the particular industry or service concerned. As an example, the appropriate department in the case of work or material for the export trade will be the Board of Trade.

Workable Control Systems and Benefits to the Enamel Plant

By J. E. HANSEN

(*Continued from page* 242.)

Pickle Room Control

The control of the cleaning and pickling solutions is one of the essential control jobs, as the basis of a well-operated plant is a closely controlled pickle room practice. Pickle room solutions may be checked by one of two methods, either by the use of pickle pills, or by chemical titration. Pickle pills, although easy to use, have a few disadvantages. Obviously, the results cannot be quite as accurate as those obtained by chemical titration, and, unfortunately, such solutions as a nickel dip cannot be tested by this method. Any plant that puts in a nickel dip will, of necessity, establish chemical control upon this bath, and with slight additional expenditure, a complete chemical titration control may be installed for the entire pickle room. Many plants hesitate to do this, feeling that it would necessitate complete laboratory equipment and man-power to run it. However, complete equipment for chemical titration control can usually be obtained at an expense of around £10 to £15 for apparatus and solutions, and any reasonably intelligent man whose fingers are not all thumbs can be trained to make the control titrations.

With the proper equipment and solutions available, the cleaner may be tested for alkalinity, the pickling acid for its acid strength and iron content, the nickel dip for its concentration of nickel salts and hydrogen ion concentration, the neutraliser bath for its total alkalinity.

Sampling of Pickling Baths for Tests

All baths should be carefully sampled in order to get a representative portion. All solutions should be thoroughly agitated before sampling, preferably by stirring with a large paddle, or by running a basket rapidly up and down through the depth of the tank.

After adding solids such as cleaner or nickel salts, the samples should not be taken for an hour, so as to be certain that all has gone into solution. Plenty of agitation at working temperature should be given during this time. Sampling of the bath is the most important part in the process of control of pickle baths, for if the sample is wrong due to insufficient solution or agitation, the time used in testing is wasted, and the data obtained may lead to incorrect conclusions.

A long-handled ladle is helpful in dipping out about six or eight ounces of solution into a suitably-sized beaker. Some plants employ a series of a half-dozen to a dozen beakers or enamel cups sunk in a framework similar to a milkman's bottle rack. In this manner, a container may be labelled for each tank, and all the samples selected and taken to the sample room at one time. These cups should be thoroughly cleaned after use, to prevent films or crystals forming on the sides, which would ruin the future sample by changing the concentration.

Testing of Cleaner

The testing of cleaner entails (*a*) the determination of the concentration (usually expressed in ounces per gallon), and (*b*) the determination of the amount of available alkali present. The cleaner solution is titrated with normal sulphuric acid, the latter being standardised either in terms of the sodium oxide (Na_2O) or in terms of ounces per gallon of the particular brand of cleaner being used.

(*a*) *Strength of Cleaner.*—For a simple determination of the strength of the cleaner in either ounces per gallon or in terms of sodium oxide, a standard-size sample, usually 10 ml., is titrated to a methyl orange end-point.

(*b*) *Available Alkali.*—It is a well-known fact that, although the total alkali present in a cleaner solution may be up to standard after several weeks or months of use, the solution will not clean effectively. It has been demonstrated that the nature of the alkali present in the cleaner changes during the time the solution is in use, perhaps partially through absorption of carbon dioxide from the atmosphere, as well as by reaction with drawing compounds on the ware which has been cleaned.

The double titration method is therefore employed in several plants exercising chemical control on cleaner tanks. The 10-ml. sample of cleaner is first titrated with normal sulphuric acid to a phenolphthalein end-point. The titration reading is recorded as the "phenolphthalein end-point" (P). To the same sample, after the pink colour has disappeared, add a few drops of methyl orange indicator, and continue the titration with normal sulphuric acid until the orange colour turns to pink. Record this reading on the burette, and call it the "methyl orange end-point" (M.O.). Remember that this reading includes the phenolphthalein titration. Assuming, for the sake of example, that the phenolphthalein end-point was 7 ml. and that the methyl orange (or total titration) was 11 ml., any of the following calculations can be made:—

$$\frac{7\ (P)}{11\ (M.O.)} = 0.636 \text{ or } 63.6 \text{ per cent.}$$

With this method of calculation, the so-called "available alkali" is designated as 63.6 per cent. The available alkali ratio on a specially made cleaner will fall as the cleaner is used, and when it is determined that the cleaner no longer acts effectively, it may be found that the ratio is down to 55 per cent., or approaching 50 per cent. For subsequent tanks of solution, this ratio may be taken as an indication of when to discard the solution.

Another method for calculation is as follows:

11.0 (M.O.) − 7.0 (P) = 4.0
4.0 × 2 = 8.0
8.0 ÷ 11.0 = 72.7 per cent. "inactive"
100.0 − 72.7 = 27.3 per cent. "active"

As the active alkali percentage decreases, the cleaning efficiency likewise decreases, and a "danger point" can be determined at which it probably will be advisable to discard the solution.

Neither of the above methods of calculation is scientifically correct for determining cleaner efficiency, but they are being used in certain laboratories and cleaning departments as a rule-of-thumb indication of when the saponifying ingredients of the cleaner have become dissipated. The value of either of these methods of calculation is seriously questioned by representatives of several cleaner manufacturers.

Testing of Acid

(*a*) *Sulphuric Acid.*

Two determinations are necessary for the complete testing of the pickling acid, namely, its strength and its iron content. This is accomplished in the following manner:

Strength.—Pipette out 10 ml. of a representative sample of acid into a 250-ml. beaker. Add 100 ml. water, then a couple of drops of methyl orange indicator. This will turn the solution red. Add drop by drop, from a burette, with rapid stirring, 2.04 normal sodium hydroxide until the red colour changes to straw yellow. The number of millilitres required to make this change is equivalent to the strength of acid in per cent. Thus, if 7.5 ml. were used to change the colour from red to yellow, the pickling acid is 7.5 per cent. sulphuric acid.

If iron be present in moderate amounts in the acid, the colour transition from red to yellow cannot be seen due to the iron coming down as a dirty green precipitate. In cases of this sort, the end-point to take is the drop that changes the solution to a permanent dirty green colour.

Iron Content.—Pipette 10 ml. of the acid into a 250-ml. beaker. Add 150 ml. of water and (carefully) 10 ml. of strong sulphuric acid. With rapid stirring, add drop by drop from a burette 0.895 normal potassium permanganate until the first pink colour remains. Each millilitre used represents ½ per cent. of iron in the solution. Thus, if 5 ml. of permanganate were used, the iron content of the pickling bath would be 2.5 per cent.

(*b*) *Muriatic Acid.*—This acid is tested exactly as sulphuric acid, except that a 2.74 normal sodium hydroxide is used instead of 2.04N. Each millilitre used represents 1 per cent. actual muriatic acid. Iron concentration is not usually checked in muriatic acid, as its presence does not hinder the action of this bath.

Testing of Neutraliser

This bath is comparatively easy to test. Pipette a 100-ml. representative sample into a 400-ml. beaker. Add 150 ml. water and a few drops of methyl orange indicator. This will turn the sample a straw-yellow colour. With constant stirring, add drop by drop from a burette normal sulphuric acid (the same acid used for cleaner determination) until the solution turns to red. Each millilitre of sulphuric acid represents 0.031 per cent. sodium oxide (Na_2O). Thus, if 17 ml. were used, the Na_2O content would be 0.031 × 17 or 0.527 per cent. Na_2O.

Testing Nickel Dip

Nickel dip is being used in many plants to improve bond, and it is important that correct strength and acidity (*p*H) is maintained. The testing of the bath is not as complicated as it seems at first sight. The following are the solutions needed:

(1) *Standard Nickel Salt Solution.*—Dissolve 4 ozs. single nickel salts in 1 gall. of distilled water.

(2) *Ammonium Citrate Solution.*—150 ml. concentrated C.P. ammonia; 120 grms. citric

acid; 200 grms. C.P. ammonium sulphate. Add distilled water to make 1 litre.

(3) *Standard Potassium Cyanide Solution.*—Dissolve 75 grms. 95-96 per cent. KCN in distilled water and make up to 1 litre.

(4) *Standard Silver Nitrate Solution.*—Dissolve 1.13 grms. silver nitrate in distilled water and make up to 1 litre.

(5) *Potassium Iodide Solution.*—Dissolve 25 grms. potassium iodide in distilled water and dilute to 100 ml.

The potassium cyanide must be standardised for its relation to a standard nickel salts solution in the same manner as sulphuric acid is standardised against cleaner. If this be done in the following order, and the determination of the concentration of the bath done likewise, no difficulty will be experienced.

(*a*) Pipette out 10 ml. of the standard nickel salt solution into a 250-ml. beaker.

(*b*) Add 10 ml. distilled water.

(*c*) Add 50 ml. ammonium citrate solution (use 100-ml. graduate).

(*d*) Add 5 ml. (use 10-ml. graduate) silver nitrate solution.

(*e*) Add 2 ml. potassium iodide (use same 10-ml. graduate). At this point the solution will become cloudy with a yellowish deposit.

(*f*) Add potassium cyanide drop by drop from a burette, stirring the solution rapidly. Keep adding until the cloudiness suddenly disappears and the solution assumes a clear straw colour. Read the burette. Assume that 4 ml. cyanide were used. This means that 1 ml. of the cyanide is equal to 1 oz. of nickel salts when using a 10 ml. sample. Whatever the factor is, record it on the bottle, and the solution is ready to be used in testing the bath.

The bath may now be sampled and run. Usually an iron scum is found in the bath, and in order to get a good end-point, it is best to filter off about 60 ml., discarding the first 10 ml. coming through. This will give enough solution to determine concentration as well as *p*H. Pipette out 10 ml. and proceed with the test as outlined under the standardisation of the cyanide. Calculate the amount of nickel salts present in the bath, and from the volume of the tank calculate the number of pounds of nickel salts necessary to add to bring it up to the correct strength.

At this point it is well to explain the difference between "single" and "double" nickel salts. "Single" nickel salts contain 1½ times as much nickel as do "double" nickel salts, and this fact must be kept in mind when adding salts to the bath. "Double" nickel salts are often erroneously thought to contain twice as much nickel as the single salts. If a bath standard be set up at 3 ozs. single nickel salts, and only double nickel salts are available, 4 ozs. per gall. of "double" must be used in order to equal the 3 ozs. of "single."

The *p*H of the nickel dip is of great importance. This is determined by means of a simple colour comparison with known standards. The standards are available in a "Block Comparator." These cover the range of *p*H 5.2 to 6.8. Thirty ml. of a filtered sample of nickel dip will be needed for the test; therefore, when filtering the sample for concentration determination, be sure to filter about 60 ml. The directions for use found with this apparatus are easily followed, and should not be difficult. The proper *p*H to keep the bath at is 5.6 to 6.2. If the figure falls below this point, ammonium carbonate or liquid ammonium can be added to the bath in small quantities until the bath is up to standard.

This determination is important, because if the *p*H is below 5.6, the bath is too acid, and no plating will result on the ware, even if the concentration is correct. In a case of this kind the nickel dip is of no value, as it serves only as a hot weak acid rinse.

Laboratory Housekeeping

Finally, in order to keep a pickling department control room at its highest efficiency, it is wise to clean thoroughly all apparatus after use. Caustic solutions should not be kept in burettes for long periods of time, as etching will take place. Before week-ends it is well to wash all burettes thoroughly and allow them to drain upside down. The stopcocks can be regreased at these intervals, and this treatment will prevent them from sticking. If pipettes are cleaned after use, they will not clog up at the tips. All in all, the few minutes spent in keeping apparatus clean and in its proper place pay large dividends in that all apparatus will be ready for use when needed and, barring breakage, will last almost indefinitely.

Ground-Coat Dipping Weight Control

The control of the dipping weight of sheet-iron ground coat is one of the simplest, yet one of the most important duties that any control operator has. Without uniformly-dipped ground coat, the whole system of standard operation is thrown off balance.

The various methods of determining the weight of enamel are fundamentally the same, in that it consists of dipping either a pickled or an enamelled sheet in the enamel and allowing it to drain at a set angle until drain is complete. Either or both the wet weight and dry weight are then obtained by weighing the sheet before and after dipping and after drying.

The type of piece to use for this test is simple; either a square piece usually giving an area of two square feet, or a hollow cylinder with the same area, is used. It can be either enamelled or pickled. There are points of advantage for both the pickled and enamelled test plate, the pickled piece giving a surface that has the same texture and "pick-up" ability as the ware being run, yet upon repeated pickling the piece becomes abnormally etched, causing an increase in the "pick-up." This necessitates the frequent change of test plates. The enamelled plates have the advantage of a constant surface and do not have to be pickled, but have the disadvantage of not being exactly comparable in the weight of enamel retained to the pickled ware being run. This necessitates a cross check between the enamelled plate and the pickled plate to set a weight on the test plate to equal the desired weight on the ware. This difference is usually rather slight.

Some plants take a piece of dried ware from the production line and brush off the enamel from an area of one square foot and weigh the residue. This weight is multiplied by two, to obtain the weight for both sides of the piece and a value comparable to other methods of testing outlined above. This method is not quite as accurate as the test plate method, as the amount of deposition on each of the two sides of a dipped piece is not quite the same, the face side being heavier. It does, however, have the advantage of measuring the actual amount of enamel on the ware being dipped.

Several factors affect the amount of enamel that is deposited on a dipped piece. The angle of inclination of the dipped piece has a definite effect on the amount of enamel retained. Thus, when a piece is drained from a perpendicular position, it retains less enamel than if it is drained at an angle. Most plants recognise this fact and always drain the test piece from the same angle, usually using a small special rack built particularly for this purpose. The angle usually used is about 80 deg. from the horizontal.

It has been found that the temperature of the enamel in the dip tank, as well as the temperature of the ware being dipped, has a very marked effect on the amount of enamel picked up by either a test plate or by the ware to be enamelled. With sheet-iron ground coat enamel of a given mill formula and water content, it has been demonstrated that the amount of enamel left on a sample plate after draining changes rapidly with changes in temperature between 40 and 65 deg. Fah., and again starts to change in the 75 to 100 deg. range. There is, however, very little change in the 65 to 75 deg. range, from which it is to be concluded that the best control of the weight of application of ground coat enamel can be obtained if the enamel slip is kept between 65 and 75 deg. Fah.

There are quite a few enamelling plants that cool their dip tank by circulating water around the dipping tank, encasing the latter with a larger tank through which the cooling water flows. Either the local water supply may be used, if its temperature be sufficiently low, or the water may be refrigerated and recirculated through the system. From a control angle, it must, however, be recognised that any extreme temperature changes in the ground coat enamel or the temperature of the ware being dipped can affect the dipping weight.

Another item that enters into the draining qualities of a ground coat enamel is the water content. This can be determined in one of two ways:—

(1) A sample of enamel itself can be weighed wet, then dried and re-weighed. The difference in weight divided by the wet weight is taken as percentage water.

(2) The wet weight of the enamel on the test plate can be taken and also dry weight determined by drying the plate. The difference in weight divided by the wet weight is the percentage water.

The water content of a properly set-up ground coat usually runs from 37 to 40 per cent. If the water content falls out of this range, it can be safely assumed that either the electrolyte addition is not correct, or the enamel is too new or too cold. If the water content is too low, the enamel usually has a long sluggish drain, with a tendency towards an "orange-peel" surface. It usually will also drain away from upper edges of a dipped piece. If the water content is too high, the enamel will drain with a watery appearance and tend to drain thin on sharp edges as well as on the bottom of long pieces. It will tend also to drain with an "orange-peel" appearance. There is also a greatly increased tendency for the enamel to water-streak.

Cover-Coat Spray Weight Control

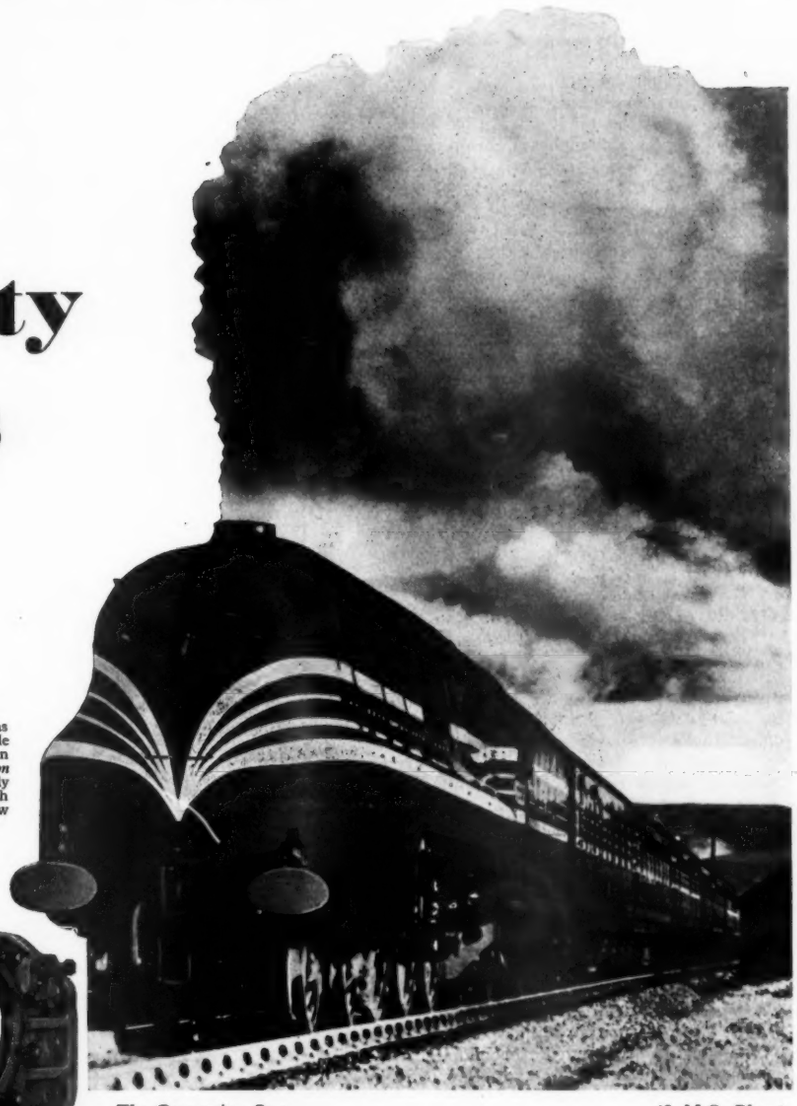
One of the most important functions of a control system is to establish the amount of cover coat being applied to the ware being run. It is a comparatively easy job to determine the thickness or weight of coating, and, if the consistency of enamel is being carefully watched, an equally easy job to control the thickness of coating. With uniformly "set-up" enamel it is possible with a minimum amount of practice for sprayers to be trained to spray any given weight, provided they are given reliable and frequent information as to what weight of coating they are spraying.

There are several methods of determining the weight of coating on ware being sprayed in a production line.

(1) One of the least desirable methods is to send a test plate of known weight and area through the spray line and weigh the dried plate, and determine the amount of enamel applied by difference. This is not particularly successful owing to the fact that the sprayer knows he is spraying a test plate and will use particular care with it, and it usually has a much different shape from production ware being sprayed.

(2) Another method sometimes used is to weigh a given part, the square footage of which is

For Quality Castings



The Coronation Scot (*L.M.S. Photo*)

In locomotive castings such as that shown below, Stanton-Dale Refined Iron was used. Dale Iron was chosen for all the ten *Coronation* class engines and can be confidently used in the manufacture of all high duty castings to rigid and narrow specifications.

STANTON-DALE REFINED PIG IRON

Grade	Silicon. %	Sulphur. %	Phosphorus %	Manganese. %	Total Carbon. %
A	1·9-2·1	0·06	0·7	0·8-1·5	2·6-2·8
B	1·4-1·6	0·07	0·7	0·8-1·5	2·6-2·8
C	0·9-1·1	0·08	0·7	0·8-1·5	2·6-2·8
D	2·4-2·6	0·05	0·5	0·8-1·5	2·6-2·8
E	0·9-1·1	0·08	0·25	0·8-1·5	2·7-2·9
F	1·4-1·6	0·07	0·25	0·8-1·5	2·7-2·9
G	1·9-2·1	0·06	0·25	0·8-1·5	2·7-2·9

In addition to the above standard grades, this iron can be supplied to individual specification.

Produced under the most rigid chemical control, Stanton-Dale is a refined iron of dense, close-grained structure, with a total carbon of 2·6 to 2·9 per cent.

The use of "Dale" iron will give a tensile strength of 16-18 tons per square inch, and it is in wide demand for the production of motor car cylinder blocks, locomotive cylinders, hydraulic and pressure work—in fact for all high duty requirements.

Any analysis can be supplied to meet individual requirements.

The Stanton Ironworks Company Limited, Near Nottingham

The largest producers in Great Britain of foundry pig iron for the free market

known. The difference in weight divided by the area gives the weight of application. The objection to this method is that it is necessary to follow one certain piece through with attendant possibilities of losing the piece, and usually the sprayer knows the test ware he is spraying.

(3) The most widely used method is to have several stencils cut with an opening of either one square foot or one-half square foot, and it is often advisable to have some rectangular as well as square. Any piece of dried sprayed ware can be taken and either a one-half or one square foot area of enamel brushed off, and this enamel can be collected on a paper and weighed. Thus, any random piece can be checked for spray weight without any preliminary treatment or weighing.

(4) A method that is used to a certain extent consists of measuring the thickness of the under-coating plus the sprayed coating and of the under-coating alone, and determining the spray coat thickness by difference. This is done with an electrical thickness gauge. A chart can be made showing the relation between sprayed enamel thickness and weight, so that it is possible to determine the spray weight directly from the thickness reading. This method is probably slightly less accurate than the one previously described, but is the faster and the accuracy is sufficient.

Any method that gives the desired results is satisfactory, and some system of spray weight control should be exercised in all shops. The effect on reduction of chipping and colour matching difficulties is very marked. It has become standard practice in a great number of plants to scrap a part that has been reworked over twice, as at that point it usually fails to pass the colour standards that have been set up. A rigid adherence to this rule will almost invariably result in a decided decrease in mounting loss as well as field replacement.

Colour Matching

The problem of colour matching and colour grading has introduced a problem of control that has involved much study as well as additional equipment. It consists of comparing the finished piece with standard plates under a special light. Usually three panels are used, and they consist of pieces that have had various weights of regular cover coat enamel applied to them. The first panel consists of a minimum weight of application, the colour of which is acceptable to the inspection department, and the second panel consists of a normal or slightly heavy application, while the third is the heaviest re-operated application that will be satisfactory. The pieces that fall within this classification are graded 1, 2 or 3, and the pieces that are lighter are re-operated, while the pieces that are too heavy are scrapped.

There have been other methods for checking this feature involving the use of photo-electric cells. This method removes the objection of the human element, but the other usual method has proved satisfactory in quite a few plants. It is necessary, however, to have a very efficient lighting system under which to do the visual colour matching, as shadows, glare and varying mixtures of daylight with artificial light make consistent colour matching practically impossible. It has been found necessary to do colour grading in special enclosed rooms, often with walls painted black, and a maximum amount of artificial light using daylight bulbs with some type of diffusion device to prevent glare. It is necessary that the lighting be so placed that there will be no shadows thrown on the ware.

Burning Control

Records may be kept reporting burning conditions in either box-type furnaces or continuous furnaces. In the case of continuous furnaces (particularly electric) it is customary to have two or more thermocouples inserted in the hot zone. The foremen in charge of the furnaces naturally must be guided by all of the various temperatures, in the in-going as well as in the actual firing zone. Often the registered temperature in the in-going zone does not reach the temperature at which the control instrument is set, due to the cooling influence of the incoming ware. If allowance be not made for this by the control of the chain speed through the firing zone, improperly fired ware may result. Checking the "set" as well as the "registered" temperatures on the various controls also enables one quickly to ascertain when elements are shorted.

Where the actual registered temperature in any one of the zones of a continuous furnace does not reach the temperature at which it has been determined that most satisfactory results will be obtained, the quality of the fired ware may suffer, even though the proper maximum temperature may be reached at some point in the burning zone. Such a condition (*i.e.*, of the registered temperature being low) may indicate that the furnace conveyor is being loaded beyond the thermal capacity of the furnace.

Control of Acid Resistance

Acid-resisting enamels have been introduced into the manufacturing picture in recent years, and if the degree of acid resistance of the parts being enamelled is of a high order of importance, the process control department should as a matter of routine test pieces of ware taken from regular production channels.

For a simple control test, a few drops of 10 per cent. citric acid solution may be placed on the test piece, and covered with a small watch glass. After fifteen minutes, the acid is rinsed off, the test piece dried, and examined for etching and staining. A soft lead pencil is often rubbed over the tested area and cleaned off as much as possible, and the sample examined for etching.

For a more exacting test, the Tentative Standard Test for Acid Resistance of Porcelain Enamels as adopted by the Technical Research Section of the Porcelain Enamel Institute should be followed.

Summary

In conclusion, it should be emphasised that process control is no new thing. The pioneer enameller, when he tasted the pickling acid, was attempting to control it. When he felt the "grit" of an enamel slip between his thumb and a finger-nail, he was attempting to control the fineness of grinding. When he judged the drain of ground coat from his hand and fingertips, he was attempting to control the consistency of enamel. Modern control systems differ from the pioneer control methods in that better tools are now available with which to make control tests, and in the greater necessity for such tests, for in many enamelling shops operations are proceeding at such a production rate that huge quantities of rejected ware can pile up in a short time if any step of the processing falls out of line with standard procedure.

The question of how much control can be economically exercised in a small plant having one or two furnaces is problematical. Control in a small plant is just as important as in a large plant, but, of course, there is not enough work for a full-time man. In plants with one and two furnaces, it is customary for the control man to have active charge of the mill room in addition to his other duties. In shops having more than two box-type furnaces, a control man with no other duties can be used efficiently, and a shop with more than one continuous furnace can use a full-time control man on each shift.

Earlier in this Paper the statement was made that process specifications were merely a set of operating rules or laws. Process control is merely the system set up to see that these rules or laws are followed.

Book Review

Report on Economic and Commercial Conditions in the Argentine Republic. By W. N. Storey. Published by H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 3s. 6d. net.

The reviewer always regards this particular Report as amongst the most interesting of the series published under the auspices of the Department of Overseas Trade from the angle of the foundry executive. In order to know something of the local foundry conditions it is germane to cite the figures for pig-iron imports. It is interesting to learn that the tonnage fell from 52,106 in 1937 to 28,235 in 1938, not because of diminished foundry activity, but on account of anxiety in respect of European conditions, the purchases in 1937 were doubled. Most of the requirements came from France, Belgian prices being too high, whilst the U.S.S.R. did not compete. The highest grades of pig-iron are still bought in Great Britain, but here a new factor has arisen by competition from Brazil. This charcoal smelted product has been selling around £5 per ton c.i.f. Buenos Aires. The quantity of cast-iron pipes imported depends on the requirements of the Argentine Sanitary Works Department, the merchant trade being supplied by this organisation. In 1938, 18,292 tons were imported as against 5,643 tons in 1937, but in the main represented deliveries against old contracts. In general, the market is dominated by Continental manufacturers.

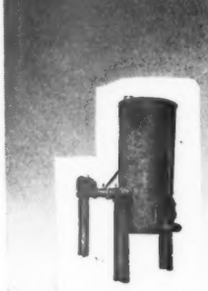
The Report has some interesting observations on cast-iron cookers and stoves which we quote *in extenso*:—

> "The rapid progress of central heating in the cities, suburbs, and even in the country is gradually reducing demand. Several local factories are producing *stoves* with a vitreous enamel finish, which are offered at prices considerably lower than those of the imported article. In consequence, although their quality is poorer, they sell better in this market where cheapness is of primary importance. *Ranges.*—The consumption of 'Supergas' continues to make striking progress as a result of the strenuous efforts made by its producers, the Argentine State Oilfields Department, to popularise it, the State undertaking having established 'container delivery' from local depôts. Gas cookers are nearly all of local manufacture, although their burners, taps, etc., are, on the whole, imported from the Continent, principally Germany. Solid-fuel cooking units for use on 'estancias' (farms) are all now manufactured locally with the exception of certain accredited trade marks of cookers of cast iron throughout which are imported from German, Belgian and United Kingdom firms, whose products have been established in this country for many years. As regards *heat-storage cookers for anthracite fuel*, despite the heavy Customs duty and high initial price, demand is increasing somewhat. The cost of these units, however, prevents them from being sold extensively, and special propaganda and servicing are necessary to arouse interest. Competition in this line is divided between Sweden and the United Kingdom."

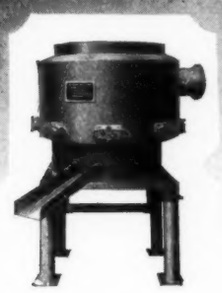
It is pleasing to learn, in respect of agricultural machinery, that United Kingdom plant was offered for sale at prices competitive with those on offer from the United States and Canada. Amongst these are cited walking ploughs, riding share ploughs, tooth harrows, hand and power maize shellers, potato diggers, small tractors for fruit growers, fruit sprayers, land levellers, lawn mowers, windmills, petrol-paraffin engines, Diesel engines

(*Concluded on page* 312.)

TITAN Over 3,800 Titan cupolas and cupolettes now in use!



Titan Cupolettes (as illustrated) are made in sizes from 10-20 cwts. per hour.



Bottom section of a Titan Cupola made in sizes from 1-20 tons per hour.

WE ARE ACTUAL MAKERS OF COMPLETE FOUNDRY PLANT, including:
CUPOLAS, CUPOLETTES, CHARGING SYSTEMS, SAND DRYERS, GEARED and CRANE LADLES, CORE MACHINES, CORE and MOULD OVENS, SAND MIXERS, AIRLESS SHOTBLAST PLANT, etc.

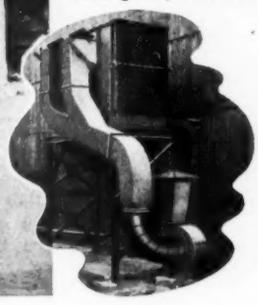
SOME TYPICAL TITAN INSTALLATIONS

Austin Motor Co., Ltd., Birmingham. 6 cupolas (2 BB cupolas; C).
Ford Motor Co., Ltd., Dagenham. 6 cupolas.
Qualcast Ltd., Derby. 7 cupolas (C : M).
Midland Electric Mfg. Co., Ltd., Birmingham. 2 cup olas (BB : C)
G. B. Parkes & Co., Ltd., Halesowen. 4 cupolas.
R. J. Hunt & Son, Ltd., Birmingham. (2 BB cupolas : C).
Royal Arsenal, Woolwich. 4 cupolas (BB).
Winget Ltd., Rochester. 5 cupolas.
Dudley Foundry Co., Ltd., Brierley Hill. 7 cupolas.

BB = Balanced blast. **M** = Mechanically charged. **C** = Complete with fans, staging, hoist, etc.

THE CONSTRUCTIONAL ENGINEERING Co LTD
TITAN WORKS, BIRMINGHAM, 12.
Telephone : MID. 4753-4. Telegrams : "STRUCTURAL."

Spenstead SHOT BLAST PLANT quick cleaning-low costs



PRESSURE APPARATUS
Great care has been taken in the design of this vital part of the Plant to ensure freedom from stoppages and full control of air and shot supply to the nozzle.

SHOT RETURN
The mixture of shot, sand, cinders and flashes, etc., which pass through the floor of the room are thoroughly separated in three stages to ensure that only clean shot returns to the Apparatus, whilst sand and oversize material are delivered through separate outlets for ease of disposal.

DUST EXHAUST
In this type of Plant, dust exhaust is of major importance, and the Spenstead Screen Filter and Fan illustrated alongside are typical of the equipment provided for the efficient ventilation of any discharge of dust to atmosphere.

We specialise on Room and Cabinet Installations incorporating Conveyors and Turntables, etc., and will gladly survey your problem and make suggestions free of cost.

PLEASE SEND FOR LITERATURE

WE EXTRACT THE **DUST** FROM IN **DUST** RY

Write to
SPENCER & HALSTEAD, LTD.,
Ossett Nr. LEEDS.

TEL.: 353-4. 'GRAMS: Spenstead, Ossett.

dm 263

Enamelling Defects Due to the Foundry*

By CHARLES DENNERY

The chief defects encountered in enamelling can arise from the choice and nature of the enamel or the choice and nature of the iron, or both together. It is proposed to study the principal defects attributable to the foundry. These are, generally speaking, of four kinds: (1) Formation of blowholes in the enamel due to liberation of gases in the iron, which tend to pass through the enamel layers; (2) difficulty or impossibility of getting the enamel to adhere properly to the iron; (3) permanent deformation set up in the iron during enamelling, and (4) crazing, due to internal tensions of the enamel during or after enamelling.

The formation of gas bubbles is the most important defect of all. It is generally put down to carbon monoxide and carbon dioxide gas, and it is interesting to learn how these are formed.

Oxidation of the Iron

The iron contains carbon in the free and the combined states. If an oxidised iron is encountered, it would seem likely that during the course of enamelling there may be one or several partial reactions between the carbon and the oxide of iron. However, this liberation of gas can be restricted or changed according to diverse complex factors, such as the position of the oxidised parts in relation to the surface and the greater or less order of the porosity of the iron at enamelling temperature; according to the greater or less order of saturation of the iron with dissolved gases at the temperature of the start of the reaction, and according to the content of atmospheric gas which surrounds the castings in one or the other of these two "elements."

Still other factors can intervene, such as the case of rust arising from a period of exposure to a damp atmosphere, or again oxidation coming about through casting. These are reasons why it is essential to control irons destined for enamelling. Deoxidation is insufficient, for it is necessary to have well-degasified irons in the case where accidentally the irons are oxidised after solidification—on fettling, for example, or even by being left about in damp surroundings. In any case, deoxidation ought to be carefully studied to ensure that oxides formed by chemical reactions may be definitely eliminated. The alkaline metals and earthy alkalis are particularly applicable, but they can introduce the drawback of poor running qualities, and castings to be enamelled are often of very thin section. A special study has to be made in each case. Aluminium should be used exercising a maximum of care, and also magnesium is useful. Its use is somewhat of a delicate matter, and usually recourse is had to cupro-magnesium. Salts are also used, such as chlorides, so as to release "reaction" gases, not the "solution" type—a function of the liquid metal.

Blowholes and Slags, Solid and Liquid Inclusions

Gas which is liberated by iron can also arise from diverse inclusions, which may be either solid or liquid. Where occluded gas is concerned, evolved or formed during crystallisation, reheating will tend to increase the volume much more rapidly as saturated iron is incapable of dissolving them. They will then seek to liberate themselves, and, because of marked pressures coming into play and the transformation of the iron on annealing, they will escape.

* Translated from the Bulletin of the Association Technique de Fonderie de France.

However, when one speaks of blowholes, holes visible to the naked eye are always envisaged. Actually, those of still smaller dimensions—pinholes, or smaller still and invisible to the naked eye—must be considered. They no longer enter into the category of blowholes, but the phenomenon is the same, in the sense that the gases instead of conglomerating in one pocket are dispersed in an infinity of intercrystalline interruptions. Only the speed of cooling, governed by the casting temperature and the thickness of the casting, intervenes in this dispersion. When these defects are invisible to the naked eye, they are the most dangerous. This is why it is preferable to discard the current appellation and to term these defects as "gas inclusions," which agrees with the more popular notion.

Moreover, solid inclusions are detrimental since they consist of slag and dirt, as well as products of oxidation. These inclusions, such as alumina, are particularly detrimental because of the porosity which they create. Thus, solid inclusions are always capable of being chemically changed and thereby liberating gas on reheating.

Chill

Many authors deem that sections lightly chilled are detrimental to enamelling, because they give rise to crazing, blowing, and offer but feeble adherence to the enamel. This is a point requiring more research, because of the extreme thinness of castings destined for enamelling. It is possible that primary chills change on enamelling, and that the heated iron graphitises, and in doing so deforms, and so renders the adhesion of the enamel difficult. The remedy is in this case to control the sulphur and manganese content and possibly to use soda ash. These occurrences often happen in irons having only a superficial white zone and in this case a light grinding is sufficient to overcome the faults indicated.

Carbon

Can graphitisation, or simply the distribution of the carbon, be sufficient to form blowholes? This is a difficult question to answer. Precise research work here makes a slight mistake and writers on the subject generally agree with the practical man that the finer the distribution of the graphite, the less the scrap. It is generally admitted that cementite should be avoided and that pearlite is to be encouraged. This problem of graphitising when reheating for enamelling is a delicate question, difficult of precise interpretation in the light of practical recorded experiences. Thus, attempts have been made to strip similar castings at varying temperatures, and it has been found that those which have been stripped when cold enamel better than those stripped warm or red hot.

This is understandable, for stripping at red heat induces an air-quenching, associated with surface oxidation. Thus, this quench, or thermal instability, taking into consideration that enamelling constitutes an annealing of the iron, foreshadows graphitisation in the surface layer which has been slightly oxidised by hot-stripping. This is sufficient to foreshadow enamelling defects, and indicates why a study of the laws of cooling is desirable, and it is possible to eliminate [materially reduce] scrap when the drawing office designs castings of regular section and the foundry sees to it that the cooling conditions are as isothermic as possible. By so doing, an important variable in the study of a very complex phenomenon is eliminated.

Precision will be further established by controlling the casting temperature. The filling of moulds is so constantly undertaken in the foundry that the fact seems to be lost sight of that, if care does cost money initially, it pays in the long run. Finally, grain refinement plays an important part in the reduction of scrap.

In conclusion, to lower scrap returns it is necessary simultaneously to churn, deoxidise, desulphurise, degas and refine—all of which are possible; but the solutions differ according to composition control, and in some way according to the idiosyncrasies of each cupola and the thermal history of the pig-irons used.

Book Review

(*Continued from page* 310.)

of 3 to 30 h.p.; lighting sets for ranches and food preparing machinery for cattle. Unfortunately the market was dull. This also applies to textile machinery. Germany, in spite of 40 per cent. cuts from the original quotations, was not particularly successful. Both American and Italian machinery imports are handicapped because of import restrictions from these countries and it is probable that United Kingdom imports should benefit. In this connection it must be remembered that the Report was written last May.

Trade was better in electrical apparatus and the United Kingdom manufactures participated in the improvement, and prospects were, at the time of compiling the Report, considered to be bright.

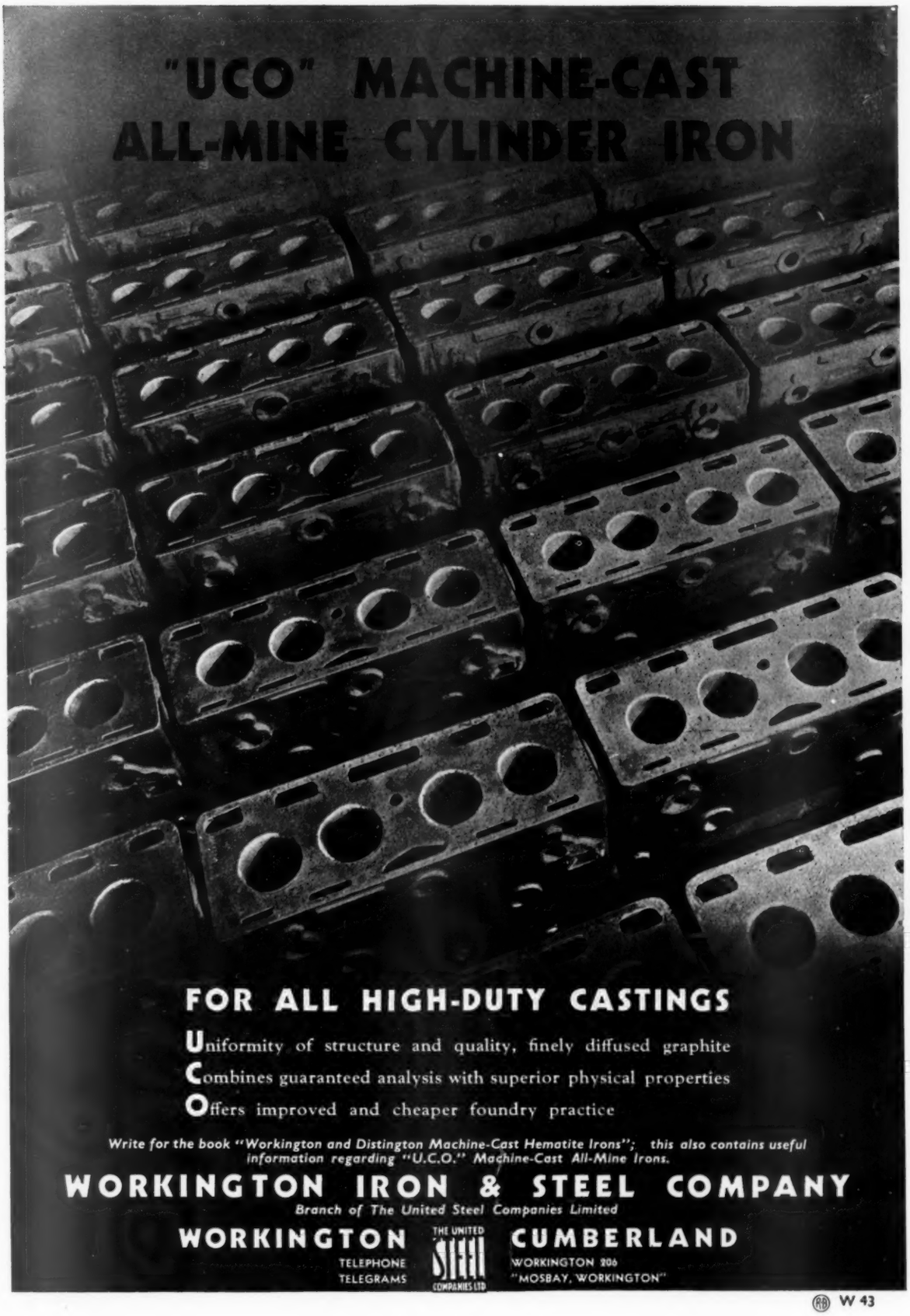
Foundries making oil engines will be interested to learn that they did best in large units of over 100 h.p., the smaller sizes going to Continental firms, especially German. A general increase of 25 per cent. was registered. In the petrol-paraffin engines, the business was predominantly with British firms.

Machine tools except for those required by the railway companies were mainly imported from the Continent, low prices being the ruling factor. In the pump section, of which over 1,000 tons were imported last year, the bulk of the trade was with the United States, due to specialisation. In the small centrifugal pump trade, however, the United Kingdom captured most of the business, the Americans getting those indented for by the Government for the petroleum industry. During 1939 and 1940, the demand for road-making machinery is expected to revive. There has been a curtailment in recent years, and, moreover, most of the equipment comes from the U.S.A.

The restriction of imports from the U.S.A. and Italy may influence the sale of motor-cars in the future, but it is not thought that the United Kingdom will benefit on account of price. This Report, which other embassy officials should emulate as far as possible, should be in the hands of all firms capable of carrying on an export trade.

Chrome Ulceration

During last year there was an increase in the number of notified cases of chrome ulceration, according to the Annual Report of the Chief Inspector of Factories for 1938. This disease is principally associated with chromium plating, which still provides the largest number of cases. The main increase last year was in connection with the process of anodic oxidation, which provided 20 cases as compared with five in 1937. The manufacture of chrome products which in recent years, compared with the early years of notification, has provided so few cases, was, however, responsible this year for 15 cases, all of which occurred at one factory where welfare facilities were good, although there was some deterioration in plant. Figures for the first six years of notification of cases of chrome ulceration, compared with those for the last six years, show a marked reduction in the number of cases in some of the older industries.


"UCO" MACHINE-CAST
ALL-MINE CYLINDER IRON
FOR ALL HIGH-DUTY CASTINGS
Uniformity of structure and quality, finely diffused graphite
Combines guaranteed analysis with superior physical properties
Offers improved and cheaper foundry practice
Write for the book "Workington and Distington Machine-Cast Hematite Irons"; this also contains useful information regarding "U.C.O." Machine-Cast All-Mine Irons.
WORKINGTON IRON & STEEL COMPANY
Branch of The United Steel Companies Limited
WORKINGTON
TELEPHONE
TELEGRAMS
THE UNITED STEEL COMPANIES LTD
CUMBERLAND
WORKINGTON 206
"MOSBAY, WORKINGTON"
W 43

The Week's News in Brief

Trade Talk

THE KEIGHLEY ASSOCIATION OF ENGINEERS is meeting this evening (Thursday) to hear a Paper on "Tungsten-Carbide Tools—Their Application to High-Speed Production Methods," by Mr. F. H. Bates, of A. C. Wickman, Limited, Coventry.

FOUR MEN in the employ of the Coltness Iron Company, having a cumulative service of over 200 years, have retired on a pension provided by the company. The men are James Sleith (aged 83), James Miller (79), John Armit (77) and James Milligan (77).

THE FIRST of the blast furnaces under erection at the Reichswerke Hermann Göring at Salzgitter was blown in last week. Construction on the furnaces commenced about two years ago. The ore used is local low-grade material, and coke is shipped from the Ruhr *via* the Midland Canal.

STAGGERED SHIFTS are being tried at some Sheffield steelworks, to avoid too large a concentration of men when one shift relieves another. Staggering is under consideration by other firms, so that excessive demands shall not be made on shelter accommodation in the event of air-raid warnings.

SIR HAROLD HARTLEY, C.B.E., F.R.S., Chairman of the International Executive Council of the World Power Conference, has asked Mr. G. J. T. Bakker, Chairman of the Netherlands National Committee, and First Vice-Chairman of the Council, to become Acting-Chairman during the war. Mr. Bakker has consented.

HEAD, WRIGHTSON & COMPANY, LIMITED, Thornaby-on-Tees, announce that their London and Birmingham offices are carrying on, though skeleton staffs are retained. In the event of an extreme emergency, arrangements have been made for the London office to be transferred to 47, The Green, Richmond, Surrey, and the Birmingham office to 12, Stoner Road, Hall Green, Birmingham.

THE Swedish Grängesberg concern exported 815,000 tons of iron ore in September, compared with 1,150,000 tons in August last and 894,000 tons in September, 1938. Iron and steel prices in Sweden have been increased by 25 per cent. The Association of Swedish Iron and Steel Manufacturers decided at a recent meeting to increase the price of all products by 60 kr. per metric ton.

THE PLANT of the National Steel Industry, near Athens (owned by John Papoulias and John Karavanos, of Pittsburgh, Pa.), in which it is intended to make steel sheets and tinplate, is reported to be nearing completion, and it is hoped that production can begin before the end of the year. Much of the necessary equipment, mainly already used, has been imported from the United States.

THE shortage of raw materials in Norway, due to the war, has led to the revival of a number of schemes, previously rejected, for the production of certain imported raw materials and manufactured goods. Plans for a national steelworks and rolling mills are being reconsidered in the light of current developments, this scheme having become more attractive in view of the better utilisation of such national resources as iron ore and cheap water-power electricity.

THE Federation of British Industries welcomed in a statement the Board of Trade memorandum on export policy as a positive step to meet the recommendations urged upon the Board of the Federation. The next step was to devise means whereby industry could plan ahead for production and export. That involved the immediate allocation of minimum amounts of raw material, a definite decision as to markets to which exports should be encouraged, and an assurance that the supply services will not absorb the whole productive capacity of firms that are normally largely employed on export work.

THE National Central Library, which has removed its headquarters to Hemel Hempstead for the period of the war, will not only continue to be of the utmost importance to those who need books for general purposes, but it will also be of greatly increased value to Government Departments, organisations, and persons needing special literature in connection with work of national importance. It will naturally give priority to the latter service, as it is recognised that in tracing material for persons doing research on all forms of armaments, chemicals, foodstuffs, medicine, and so on, the Library will be filling a gap, the existence of which was so serious a drawback during the last war. The organisation of the National Central Library, with its great Union Catalogues and other unique bibliographical material, and the access it has to over twenty-one million books in other libraries in the British Isles, places it in an exceptional position to give a service of special value in time of war.

A CAST-IRON type of trench shelter is now being produced by Jackson, Elphick & Company, Limited, Larkhall, Lanarkshire. Nearly all works are now required to provide shelters for their employees, and to meet this demand, the British Cast Iron Research Association, in conjunction with a body of ironfounders, designed this type of cast-iron shelter and had the construction tested by the Home Office. Federated Foundries (of which Jackson, Elphick & Company, Limited, is a constituent company) have decided to construct shelters of this type throughout their various works, and already several shelters have been completed at Walter MacFarlane & Company's Saracen Foundry, Glasgow. The shelter at Larkhall will provide accommodation for 50 people. Its length will be 43 ft. 6 in. by 5 ft. broad, and 6 ft. 6 in. in height. The plates are about 2 ft. 6 in. by 1 ft. 3 in. The shelter can be erected by unskilled labour, the plates bolting easily together.

Personal

DR. HAROLD HARTLEY, head of the research section of Radiation, Limited, has been appointed a technical director of that company.

CAPT. P. G. CAREW and Mr. E. A. Reynolds have been elected additional directors of Tube Investments, Limited. Mr. L. A. R. Stedeford has been elected joint managing director with Mr. J. H. Aston.

MR. S. T. GARSON, works manager, Mr. Arthur Kirton, secretary, and Mr. L. F. Wright, assistant works manager, have been appointed additional directors of Gjers, Mills & Company, Limited, Ayresome Ironworks, Middlesbrough.

MR. JOSEPH J. CARTER, managing director of Crossley Bros., Limited, of Openshaw, Manchester, and chairman of Crossley-Premier Engines, Limited, Sandiacre, Nottingham, has been elected president of the British Engineers' Association.

MR. BERNARD FISHER, an employee at the Templeborough works of Steel, Peech & Tozer, Limited, has received a Carnegie Hero Trust Fund certificate and cheque for bravery when he rescued a fellow worker from a blazing crane at the works.

MR. B. HALLOWS GARSIDE, who has been connected with the parent company, Crompton Parkinson, Limited, and its associated companies since 1927, has been appointed a director of Derby Cables, Limited. Mr. Garside is general manager of Derby Cables, Limited, and he will continue to hold this appointment.

MR. C. F. DICKSON, Mr. J. Harwood Fryer, Col. C. Hardie and Mr. T. H. Windibank have been appointed executive directors of Crompton Parkinson, Limited. The board has decided to change the directorial and managerial structure of the company. This, in the opinion of the directors, will be of valuable assistance to the future management of the company. The company's articles have been altered to permit of the appointment of officials as executive directors. Mr. Dickson and Mr. Windibank are sales managers, Mr. Harwood Fryer is secretary of the company, and Col. C. Hardie is general manager of the Chelmsford works of the company.

I.B.F. Members Serving with the Forces

The following is an additional list of members of the Institute of British Foundrymen serving with His Majesty's Forces. The Secretary of the Institute would appreciate corrections and further additions as it is desired to establish a complete register:—Mr. B. Haigh; Mr. P. B. Lake; Col. C. A. B. Lindop; Mr. N. L. Lloyd; Mr. R. B. Newton; Mr. E. J. Nation; Mr. E. A. Phillips; Col. C. Portway; Mr. S. P. Russell; Mr. T. Shanks; Mr. F. W. Taylor; and Mr. J. G. Turnbull. In the last list published the name of Mr. John Hird was erroneously included.

New Non-Ferrous Metals Order

SCRAP PRICES FIXED

The Control of Non-Ferrous Metals (No. 4) Order, 1939, amends the schedule of maximum prices attached to the Non-Ferrous Metals (No. 2) Order, 1939.

The following items have been deleted:—Zinc sulphide, lithopone, 28 to 30 per cent. and 60 per cent., and zinc dust. New prices included in the schedule are:—Zinc sheets (No. 10 gauge and thicker), £30 12s. 6d., ex-works (for lots of 5 tons and over); rolled zinc (boiler plates), £28 12s. 6d., ex-works; hard spelter and dross, £11, ex-works; zinc oxide (Red Seal), £21, delivered buyers' premises.

Prices for various descriptions of non-ferrous scrap have now been fixed, as follow:—

Copper.—Bright untinned copper wire in crucible form or in hanks, £49, delivered buyers' premises; No. 1 copper wire, £48 10s., delivered buyers' premises; No. 2 copper wire, £47, delivered buyers' premises.

Brass.—Q.F. process and shell-cases, 70/30 quality (free from primers), £41, delivered buyers' premises; clean fired 303 S.A. cartridge cases, £39, delivered buyers' premises; 70/30 turnings, clean and baled, £35, delivered buyers' premises; brass swarf (clean commercial, free from iron; otherwise subject to allowance for moisture, iron and other impurities at buyer's valuation), £27, delivered buyers' premises; new brass rod ends, 60/40, £31, delivered buyers' premises.

Admiralty Gunmetal Scrap and Swarf.—88 :10 :2 (for quantities of 2 tons and over), £60 10s., delivered buyers' premises.

The new Order also contains certain fresh provisions, as follow:—

Zinc Sheets.—The amount of any customary trade extras or allowances for sheets of thinner gauge than No. 10, for lots of less than 5 tons, or for sheets of unusual size or quality may be added to the price; in respect of zinc sheets sold by *bona fide* merchants carrying on business as such at the date when the above Order came into force (October 25), the customary trade charges for unloading, storage, delivery and similar services, may be added to the price.

Zinc Oxide.—The above prices for zinc oxide are for lots of not less than 2 tons each. For lots of less than 2 tons the customary addition may be made to the price.

Article 2 of the Control of Non-Ferrous Metals (No. 3) Order, 1939, ceases to apply to zinc oxide, zinc carbonate, and zinc dust.

Reports and Dividends

Tweedales & Smalley (1920), Limited—Interim dividend of 2½ per cent.

Light Alloys, Limited—Final dividend of 20 per cent., making 35 per cent.

Drake & Gorham, Limited—Profit for year to June 30, £538; no dividend is declared.

J. A. Crabtree & Company, Limited—Net trading profit for the year to July 30, £161,275.

Allied Ironfounders (Ireland), Limited—Net profit to June 30 last of £235, reducing the debit balance to £16,697.

Obituary

MR. ANDREW AITKEN, secretary of Cameron & Roberton, Limited, ironfounders, Kirkintilloch, has died at the age of 78.

MR. WILLIAM WILKINSON, machinery merchant, of Leith, has died at the age of 61. Mr. Wilkinson was a native of Edinburgh. He entered his father's business over 40 years ago. About a year ago the firm of John Wilkinson was formed into a limited liability company under the name of John Wilkinson, Machinery & Tools, Limited.

Forthcoming Events

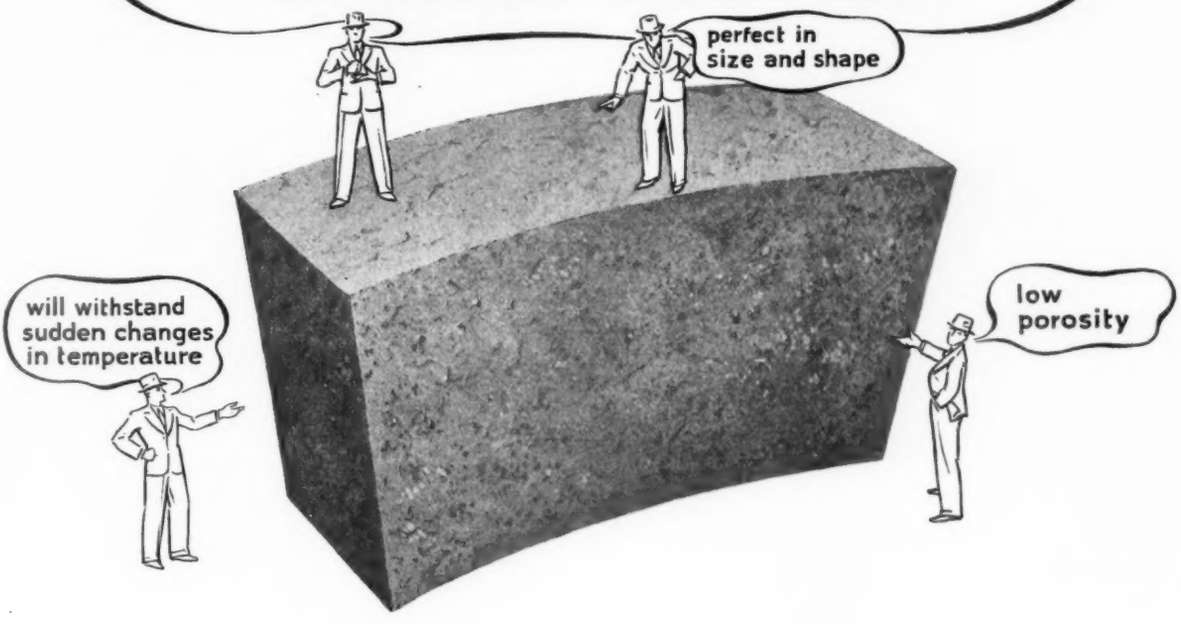
Institute of British Foundrymen

NOVEMBER 4.

Lancashire Branch:—Foundry Problems, discussion introduced by A. Sutcliffe and A. Jackson, at Engineers' Club, Manchester, at 3 p.m.

Wales and Monmouth Branch:—Members' discussion, opened by F. G. Jackson, at University College, Newport Road, Cardiff, at 3 p.m.

Reliability - is certainly the word to describe these bricks



The firebricks supplied by General Refractories Ltd. can be relied upon to give complete satisfaction. Brands of firebricks are manufactured to meet every requirement and the utmost care is taken in the production of both standard sizes and special shapes, so that they are always of the same high quality. Due to the fact that our works are situated at points throughout the country, it is often found that delivery can be given from a works close to your own vicinity and, therefore, railway rates are reduced to a minimum — a very important consideration. Our Technical Staff is at your service for advice on any problem regarding the selection of the correct grade of firebricks to meet your exact needs.

Write NOW for full particulars

GENERAL REFRACTORIES LIMITED,

GENEFAX HOUSE, SHEFFIELD, 10.

Telephone: Sheffield 31113 (6 lines) *Telegrams:* "Genefax Sheffield."

Raw Material Markets

Pig-iron Prices Increased: All Supplies Now Subject to Licence: Castings Prices Controlled

An announcement with regard to prices of iron and steel to rule as from November 1 was issued on Wednesday, and, as was expected, reveals that substantial increases have been made. In normal times consumers naturally desire to have new prices before them some time before they are due to come into force, but owing to the strict control now exercised over industry generally there has been less agitation for the publication of the new prices, although in many quarters it had been hoped that the Control authorities would have found it possible to announce them sooner than the day when they were due to come into operation. The price of foundry pig-iron has been raised by 9s. per ton, hematite is also 9s. dearer, while semi-finished steel has been raised by 20s. per ton, and the increase on finished steel is from 20s. to 27s. 6d. With a heavy demand for most descriptions of iron and steel the increased prices will have little or no effect on business and producers are experiencing no difficulty in disposing of their full outputs. The new prices are incorporated in the list on page 12.

The amending Order made necessary by the changes in prices also covers additions and alterations some of which are of particular interest to the foundry trade. Steel and iron castings are made subject to price control, and other products maximum prices for which are laid down are home iron ore, high-speed steel, wire, forgings, and tyres, axles and solid wheels.

Under the direction attached to the Order, pig-iron has been excepted from the various exemptions from licence, and purchases therefore in every case require a licence. This step has been taken, it is intimated, in order to prevent any hold-up in necessary supplies. Suppliers of pig-iron are authorised to make deliveries up to and including November 14 against contracts made prior to November 1 where they are satisfied that the consumer requires the iron for current consumption. All consumers, however, should apply immediately for licences, as this general permission will not be extended. Iron castings which have been subjected to any process other than moulding, fettling, annealing or painting may until further notice be acquired by exempted persons without licence.

Prices of low-phosphorus iron have, as was anticipated in these columns, been brought within the range of the Control. Iron with 0.5 per cent. to 0.75 per cent. phosphorus has been fixed at £5 17s. 6d. and with 0.1 per cent. to 0.5 per cent. at £6 6s., both delivered Birmingham. Other prices are:—Cylinder and refined irons, £7 16s. North Zone, £7 18s. 6d. South Zone. South Staffordshire cold-blast pig-iron, £10 1s.

As regards steel castings it is laid down that rates shall be the "prices set out in the related schedules plus 10s. per ton."

With regard to iron castings the Order states that the rate shall be "the seller's latest price ruling in 1939 before September 1, 1939, with the addition of 10s. per ton or an equivalent percentage."

Pig-Iron

MIDDLESBROUGH—The announcement with regard to the new prices for foundry iron has made little difference to conditions in this area. Most consumers are compelled to purchase their requirements from other districts, owing to the fact that most of the pig-iron makers in the Cleveland area are employed on the production of other grades of iron. Stocks of iron, on the whole, are satisfactory and fresh imports, although now duty free, are not being taken up at present. The British Iron and Steel Corporation will be able to obtain greater supplies from abroad for disposal to British steelmakers, however, and in this respect the decision to remove the import duty was wise. Foundrymen may now be expected to buy ahead on a large scale, as most of them are well employed and have heavy requirements of iron up to the end of the year. The turnover in hematite continues to be very substantial and makers are producing to the limit of their capacity. Stocks are down to low levels, but the position is not unsatisfactory, as the reserve furnace capacity is quite considerable; while supplies are going though quite freely to the Midlands and the Sheffield areas.

LANCASHIRE—The lack of information regarding prices for deliveries after the end of the month did not hold back any unreasonable amount of business, as consumers, being busily employed on Government work in many instances, were not in the position to await the price decision. Most consumers of foundry iron obtain their requirements from the Midlands, where producers are despatching supplies as soon as they become available. There has been a material improvement in the conditions of jobbing founders, most of whom are now actively employed, whereas a few weeks ago the majority of firms in this branch were in need of additional orders. Light-castings makers, too, are now better placed. Probably the most active consuming sections, however, continue to be heavy electrical engineering and the machine-tool trades.

MIDLANDS—The distribution of iron in this area is proceeding on satisfactory lines and all consumers' applications for supplies receive fair consideration, although, of course, preference is given to users engaged on work of national importance. On the whole, there are ample supplies of iron and deliveries are being made quite freely. It is not always possible to distribute the specified grade of iron, but most consumers are satisfied with a suitable alternative. The higher prices now in operation are not likely to restrict business to any extent and makers' outputs are assured of steady disposal for a considerable time ahead. Supplies of low-phosphorus iron, which recently have been on the short side, are coming through more quickly and this improvement is likely to be accentuated in the near future. Hematite remains in strong demand and supplies are adequate to meet consumers' requirements, as stocks continue to be substantial.

SCOTLAND—The new prices for foundry iron came into force yesterday (Wednesday). The heavy demand for iron which has recently been experienced will not suffer as a result of the increased quotations and makers are understood to be considering expanding their outputs, as the 14 furnaces at present in operation are barely sufficient to meet all demands. A shipment of foundry iron recently arrived from Australia and this will help to expedite deliveries to some extent. With local steelworks working to capacity the call for supplies of steel-making irons is very heavy and the frequent arrival of shipments of foreign basic iron in the Clyde is relieving the situation.

Coke

Although most consumers of foundry coke have covered their immediate, and in some cases forward, requirements, business continues to be on a good scale, as most users are building up reserve supplies, which will stand them in good stead in the winter, when transport difficulties may be encountered. Recent business has included a protective clause which ensures that makers will not suffer from increased quotations, and in view of the higher prices now ruling for iron it is expected that coke prices will also be raised.

Steel

Higher prices have now been introduced for steel, but the demand will not be affected to any extent owing to the urgency with which supplies are needed. Some delay is inevitable, but deliveries are being speeded up as far as possible to consumers engaged on work of national importance. Higher prices were inevitable in view of the additional costs involved in the purchase of raw material supplies.

Scrap

The nation-wide campaign for the collection of scrap is understood to have made an auspicious start. The activities of the authorities during the first week were concentrated on the London area and about 20,000 circular letters are believed to have been despatched to likely concerns, to which a gratifying number of replies has already been received. Works' proprietors are apparently responding to the appeal to release all unwanted scrap. By the time that the United Kingdom has been systematically canvassed it is expected that the results will be very important to the national effort. Householders will be among the last to be circularised, but in the meantime it is thought that the response may be considerable from this source.

Metals

Details of a new Non-Ferrous Metals Order issued by the Control authorities are outlined on page 314. Certain revisions have been made in existing prices, while a number of deletions have been made in respect of other commodities. Prices have also been fixed for non-ferrous scrap.

Copper—Britain's wartime requirements of copper will, of course, be considerably greater than in peacetime and thus the news that Canadian producers are fulfilling an order for 420,000,000 lbs. of electrolytic copper has been received with satisfaction in this country. The value of the order is understood to be around $46,200,000 (approximately £9,000,000). Deliveries to consumers in this country are fairly satisfactory now that the Control system is operating more smoothly than was the case at the outbreak of the war. Certain grades of metal, however, are still difficult to obtain, especially for prompt delivery. Trouble seems to be experienced by firms wishing to accumulate reserve stocks, but this can scarcely be obviated while the market remains so closely controlled by the Ministry of Supply.

Tin—As we have frequently pointed out of late, tin stocks in this country are now at an unreasonably low level in view of the country's increased requirements and, in the circumstances, it might have been considered inadvisable to issue export licences for the shipment of tin in large tonnages, as was the case, especially, to the United States. On Monday it was announced by the Board of Trade that it had been decided temporarily to suspend the issue of export licences for metallic tin. This, of course, represents a complete reversal of policy on the part of the Government, but will be welcomed by consumers. The Minister of Supply has reiterated the Government's intention of maintaining the maximum tin price in this country; he said that the removal of the maximum price could only be considered when market conditions became more normal.

An early announcement of a further increase in the tin quota is anticipated on the London Metal Exchange; it is thought that the quota will be increased from 70 to 80 per cent. for the fourth quarter.

Spelter—Deliveries to consumers continue to be on a satisfactory scale and consumption is reported to be fully maintained. National defence requirements are being met by many working-up industries and little relaxation in the demand may be anticipated for a considerable time.

Lead—While most consumers appear to be receiving supplies without much undue delay, some users report that delays are unreasonable. Lead is expected in large supplies from Empire sources, and in view of the manner in which the British Navy is dealing with the menace of German submarines, there should not be much difficulty in getting through the necessary supplies.

Scrap—There is a big demand for most grades of scrap and, unfortunately, supplies are causing some concern. This is partly caused through producing works consuming large tonnages themselves, while demolition work is less than it was before the war. The new prices fixed by the Control are on another page.